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SPECIAL BULLETIN-8

FISHERIES TECHNOLOGICAL EXPERIMENT STATION
C.F.T.R.I.
29.11.82
MANGALORE

abstracts of CIFT PUBLICATIONS

1957 TO '80

CENTRAL INSTITUTE OF FISHERIES TECHNOLOGY
(Indian Council of Agricultural Research)
MATSYAPURI P. O., COCHIN - 682 029, INDIA

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CENTRAL INSTITUTE OF FISHERIES TECHNOLOGY

(Indian Council of Agricultural Research)

MATSYAPURI P. O., COCHIN – 682 029, INDIA

Rs. 15/-

DEDICATED TO THE MEMORY OF LATE
SHRI G. K KURIYAN, DIRECTOR, CIFT

FOREWORD

It is commendable that the Central Institute of Fisheries Technology is bringing out a Special Bulletin containing 24 abstracts of scientific, technical and general papers published by the scientists of the Institute since its inception. This would be a very useful compilation for all those interested in improved fishing methods and post harvest technologies.

I am particulary happy to learn that this Special Bulletin is being dedicated to the memory of late Shri G. K. Kuriyan who as the Director of the Institute was largely responsible for its present level of growth and development.

O. P. GAUTAM
Director General
Indian Council of Agricultural Research
Krishi Bhavan, New Delhi-110001

New Delhi
14th October, 1980

PREFACE

The Bulletin No. 8 viz. 'Abstracts of CIFT Publications' contains the abstracts of publications brought out from this Institute from its very inception. It is hoped that this publication would be useful not only to research workers in the field of fish harvest and post harvest technologies but also to students of Fishery Sciences and entrepreneurs engaged in fishing industry as a source of ready reference. It is but apt that this bulletin is specially dedicated to the memory of the late Shri G. K. Kuriyan who made immense contribution to the development and growth of the Institute. I am glad to note that Smt. P. J. Cecily and Shri N. Subramanian have executed this work in a commendable way adopting the currently accepted documentation system.

Cochin,
5-8-1981

Dr. C. C. PANDURANGA RAO
Director, C I F T

INTRODUCTION

This publication covers 715 scientific, technical and general papers published by scientists of Central Institute of Fisheries Technology from April, 1957 to 5th August 1980. The material has been broadly classified into different subjects and subheadings under each. The abstracts have been arranged in chronological order with author's name in alphabetical order. Each entry in the publication is listed in seriatim

1. Name of the author(s) followed by initials
2. Full title of the paper
3. Name of the journal (in abbreviated form) or the name of conference/publication
4. Volume No., Issue No. within brackets, year of publication and page numbers
5. Abstract of the paper given with due emphasis on the research findings
6. Abbreviations
7. An author index for easy reference of the publication of a particular author(s)

In some instances the authors, abstracts are reproduced.

We are grateful to Dr. C. C. Panduranga Rao, Director of the Institute for giving guidance in the preparation of this bulletin and according permission for its publication. We acknowledge with gratitude the immense help rendered by Shri T. K. Govindan, Scientist, by way of going through the manuscript and making valuable suggestions in the presentation of the material. We are also thankful to Dr. P. N. Kaul, Scientist-in-charge of the Extension Division for his encouragement and to Smt K. Radhalakshmy and Smt. T. T. Annamma for assistance rendered in the preparation of this bulletin.

Cochin
5-8-1981

P. J. CECILY

N. SUBRAMANIAN

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CRAFT TECHNOLOGY

MATERIALS

1. BALASUBRAMANYAN (R)

Technological characteristics of wood as a building material for fishing boats. *Proc. Indo-Pacif. Fish. Coun., Occ. Pap.* 64/9, 1964.

Fishing boats play an important role in fishery industry. More and more of modern designs of mechanised fishing boats are constantly added on to the existing fleet. Under the prevailing economic conditions in India, the indigenous timber resources have to be exploited to the fullest extent as wood will be the main constructional material for fishing boats for many years to come. The author narrates briefly the technological characteristics of wood as a building material for fishing boats.

2. BALASUBRAMANYAN (R)

Fishing crafts of India and the different timbers for their construction. *Proc. Indo-Pacific. Fish. Coun., Occ. Pap.* 64/6. 1964.

A general account of the boat types and the most common timbers that are used for their construction is given in the paper.

Venteak timber has excellent bending properties and as such is extensively used for bent frames in boats. The hull and deck planking is mostly done with 'Anjili' though 'Teak' is also used occasionally. With the advancement in the field of timber technology and wood preservation it would be possible to select suitable timbers that have been recommended from the easily available and cheap secondary species for treatment and use for boat building purposes.

3. BALASUBRAMANYAN (R)

Cheaper fishing boats with newer constructional materials. *Seafood Exporter.*, 2 (4), 1967 : 9–19.

With a view to finding out a possible cheap substitute for teak and aini, a number of species of timbers suitable for boat building were examined and put to standard tests taking into consideration their properties, availability and cost. As a result 'Venteak' wood has been recommended for boat construction. Experiments with indigenous aluminium-magnesium alloy as a hull sheathing material in lieu of imported copper sheets gave promising results. Boat fastenings and fittings are yet other source of heavy expenditure in fishing boat construction. Ferrous structures with a tough surface coating of zinc (galvanizing) last longer when used both above and below waterline of a fishing boat.

4. RAVINDRAN (K) and BALASUBRAMANYAN (R)

Spheroidal graphite austenitic cast iron for marine propellers. *Seafood Export J.*, 1 (4), 1969 : 1–3.

Austenitic cast iron known under the trade name Ni-RESIST has been rendered austenitic by adding sufficient amount

of alloy element mainly nickel. The austenitic matrix in this iron offers better corrosion resistance and toughness than ordinary cast iron. A perusal of the data presented reveals that Ni-Resist is as suitable as manganese bronze for propellers.

The corrosion resistance of this material is better compared with manganese bronze under specially simulated condition. Ni-Resist marine propellers are economic as they last longer.

5. BALASUBRAMANYAN (R)

On the characteristics of some of the Indian timbers for boat building. Part I. *Indian Seafoods*, 7 (4), 1970 : 27-33.

After a careful study of the properties of boat building timbers venteak wood has been selected as a cheaper substitute for teak and aini. Main characteristics of 18 different species of timbers were studied in comparison to the standard timber, teak. Studies have revealed that none of the Indian timbers can resist the severe attack of marine wood borers under prolonged immersion in our tropical waters, however much they are otherwise excellent in their mechanical or strength properties. This phenomenon still necessitates the need for the sheathing of all wooden hulls of mechanised fishing boats either with metallic or non-metallic materials.

6. BALASUBRAMANYAN (R)

On the characteristics of some of the Indian timbers for boat building. Part II : Technological features. *Indian Seafoods*, 8 (1), 1970 : 12-17

Specific gravity of timbers is an excellent index to their strength properties at a given percentage of moisture content. The pH value of wood is of high importance in wood research and application. Timbers with low pH value might cause metal corrosion due to the acidity and humidity in wood. Timbers easily deteriorate due to mechanical wear and tear and are most easily destroyed by fire. Being an organic matter, wood is subject to decay due to fungus infection and insect damage, against which, proper protection and care are essential. Data on 12 timber species are presented in a tabular form in this paper.

7. BALASUBRAMANYAN (R)

On the characteristics of some of the Indian timbers for boat building. Part. III : Wood seasoning and preservation. *Indian Seafoods*, 8 (3), 1970 : 23-26.

The paper describes the salient features of wood seasoning and preservation with a view to suggesting cheaper alternative substitutes for teak, aini, venteak and the like for boat building purposes.

Eventhough seasoning of wood improves many of its properties, seasoned wood does not necessarily acquire any special resistance or immunity against biological deterioration which is quite common in all organic materials. The physical and chemical characteristics of the different woods may play important roles in determining their susceptibility to impregnation with toxic preservatives as mere surface coating will not give the desired level of protection. Apart from preservatives, paints and other surface coatings applied to wood offer protection against weathering and fire.

8. BALASUBRAMANYAN (R)

Substitute materials for wood and steel for the construction of fishing boats in India: A review. *Indian Seafoods*, 9 (1), 1971 : 11-15.

In this communication, the author gives an account of a few important background data on the craft materials such as aluminium, FRP, Ferrocement, steel and wood. Based on prototype studies, an estimation of hull work and material content for 100 ft combination vessel of a basic design but in different materials constructed as per Lloyd's rules has been made. Considering both the merits and demerits of these new constructional materials fibre glass reinforced plastics, ferrocement and aluminium alloys are bound to play vital roles in the development of fishing crafts in India as suitable substitutes or alternative materials for the conventional wood and steel both of which are becoming scarce at present.

9. BALASUBRAMANYAN (R)

Fishing boats out of steel and cement ('Ferrocement') : World opinion. *Seafood Export J.*, 4 (1), 1972 : 137-142.

A combination of steel and cement named, Ferrocement or 'Ferroconcrete' has come into the field as an alternative material for construction of fishing boats. The material exhibits all the mechanical properties suited for fishing boat construction with very many advantages over the conventional ones. Considering all the facts and figures that go to recommend ferrocement as a constructional material for fishing boats, India has to give a fair trial to this new material. Further studies may, however, be necessary on specific aspects like design considerations, construction techniques, strength and durability of ferro-cement structures. Ferrocement fishing boats have become popular all over the world and this material has been accepted and approved by Lloyds Register of Shipping, Bureau of Veritas, the U. K. White Fish Authority and the FAO of the UN.

10. BALASUBRAMANYAN (R)

Utilization of treated wood, steel, fibreglass, ferrocement and aluminium in the construction of modern fishing boats and their comparative coast analysis. *Fish. Technol.*, 10 (1), 1973 : 33-43.

Modern fishing boats have to be built with sound and strong construction materials that ensure a long lasting, trouble-free service commensurate with the heavy capital investment involved. Choice of construction materials for fishing boats needs careful scrutiny as they have to perform well under most aggressive environments – seawater and marine atmosphere. A number of alternative boat building materials are now available whose comparative merits and demerits as well as comparative costs are brought out in this paper. The new materials like fibreglass reinforced plastics, ferrocement and aluminium, if put to proper use, can relieve the present strain on the conventional materials like steel and wood.

11. BALASUBRAMANYAN (R)

Wider choice of construction materials for the modern fishing boats. *Fish. Technol*, 12 (2), 1975 : 87-93

An account of newer construction materials like aluminium, fibreglass reinforced plastics and ferrocement for modern fishing boats has been detailed.

12. UNNIKRISHNAN NAIR (N), RAVINDRAN (K) and GOPALAKRISHNA PILLAI (A G)

Studies on the influence of moisture and specific gravity on the strength properties of Mango wood (*Mangifera indica*). *Fish. Technol.*, 16 (1), 1979 : 7-9.

Small differences in moisture content and specific gravity are known to influence the strength properties of timber. The influence of moisture and specific gravity on the strength of mango wood (*Mangifera indica*) is discussed.

The co-efficient of correlation between specific gravity and breaking strength was found to be nonsignificant The relation between strength and moisture was found to be highly significant. The mean strength values indicated a reduction when the moisture increased from 8.5 to 18.8%. However, no appreciable difference in strength values could be observed when moisture increased about 37%. The strength moisture relationship is a saturation point. By using the exponential formula, the breaking strength corresponding to any moisture level between zero and fibre saturation can be determined.

DESIGNS

13. BALASUBRAMANYAN (R)

Fishing crafts employed in the pearl and chank fisheries of Gulf of Mannar, India. *Symposium on Pearl Oyster, chank and their fisheries in India. Zoological Soc. (India) Mandapam Centre*, 1959.

The paper gives an account of fishing crafts employed in the chank and pearl isheries of Gulf of Mannar. The Tuticorin sailing canoe used by the divers in the Gulf of Mannar is an open wooden boat. The hull is partially framed with natural 'crooks' of 'poovarasu' secially selected for the purpose. The pearling canoes are usually about 30 to 40' long and are of $2\frac{1}{2}$ to 3 tons displacement with a shallow draft. The boat carries a single mast of either teak or casuarina of moderate height rigged a little forward of midship with a canvas sail of nearly 340 sq. ft. The pearl fishery tug is expected to tow about 70 to 80 pearling canoes at nearly 4 to 5 knots speed. The author describes a tug-cum-trawler which would be suitable for towing purpose during the pearl fishing season and afterwards for regular commercial trawling.

14. KURIYAN (G K) and BALASUBRAMANYAN (P.)

Certain aspects about improved designs of small fishing boats for India. *J. Naval Architecture & Marine Engg., Soc. SI. No.* 40-49 1959.

In this communication, the authors endeavour to present certain aspects relating to the improved designs of small fishing boats. While designing new types of fishing boats, the average cost involved in operating such boats, their capital outlay and the basic requirements should be considered. The communication gives s brief list of new designs of wooden fishing boats introduced in India.

15 KURIYAN (G K) and KRISHNAMURTHY (B)

On the results of fishing with small motorized boats in Madras State. *Indian Fish. Bull.*, 6 (3), 1959 : 36-39.

The present paper, embodies an evaluation of the success of the general scheme

of mechanisation of fishing with small motorized crafts, particularly the so called 'Pablo' type boats. The number of days of fishing possible with a motorized boat is much more than that with a catamaran. The annual earnings of a motorized boat would consequently be increased considerably. It also deserved mention that fishing would be possible without depending on wind, different fishing grounds can be covered within a short time, increase the fishing hours and bring the catches without spoilage. Mechanical fishing accessories like gurdies, winches etc. if provided to the boats would not only constribute to the fishing qualities on the boats but also make them suitable for operation of other modern gear and thereby increase the catch efficiency.

16. BALASUBRAMANYAN (R)

Review of fishing boat types and their design aspects. *J. Naval Architecture & Marine. Engg., Soc.*, 1960 : 22–27.

The paper present a general review of some important boat types for the exploitation of both inshore and offshore fishery resources.

17. CHOUDHURY (R L Roy)

Propeller selection for small trawlers. *Proc. Indo-Pacif. Fish. Coun.*, 10 (3), 1962 : 87–93.

The conditions of working and the special features of small fishing boat propellers are brought out in detail with special reference to trawlers. The feasibility of using standard series diagrams for design analysis is discussed. A useful chart is specially devaloped which presents the power absorbed and the thrust developed by a propeller in the trawling condition purely in terms of the diameter and the pitch ratio.

18. CHOUDHURY (R L Roy)

Layout for small fishing vessels. *Indian Fish. Bull.*, 9 (3), 1962 : 1–5.

The paper gives an account of the lay out of small fishing boats especially the open type sizes 25'–0 and 30'–0, half decked boat of 38'–0 and full decked boats of 32'–0 and 36'–0. Trawling necessitated the mechanisation of fishing method and the question of layout became more complicated. In this article, the problems of the layout of fishing vessels are briefly discussed and features of the above boats are described.

19. GOPINATHA KARTHA (T D) and CHOUDHURY (R L Roy)

Trawling pull exerted by a trawler : A method of estimation from propeller dimensions and its comparison with sea measurements. *Fish. Technol.*, 3 (2), 1966 : 146–157.

The method consists in an accurate calculation of trawling pull by taking into account the propeller diameter, pitch and r. p. m. of the vessel. The predictions by the method are compared for trawlers with powers between 30 and 60 H. P. The power absorbed by the propeller in trawling condition can also be calculated by this method for checking whether the engine is being overloaded.

20. KURIYAN (G K)

Fishing boat development in India. *Seafood Export J.*, 1 (11), 1969 : 21–28.

The development of fishing fleet in many advanced countries has been spread over a period of several years and has possibly led to the evolution of many distinct types of crafts, each type adopted for a particular fishery. Consequent on the expansion of the shrimp processing industry, interest in the trawling technique increased and more and more larger boats were introduced. Simultaneously gear handling and fish detection facilities also improved. Fishing boat development had thus registered steady progress and one could anticipate that the country will be having a well equiped fishing fleet ere long.

21. RAJENDRAN (R) and CHOUDHURY (R L Roy)

Scantlings for small wooden fishing vessels. *Fish. Technol*, 6 (2), 1969 : 98–107.

A suitable basis for specifying scantlings for wooden fishing vessels of 30' to 50' overall length has been worked out.

22. RAJENDRAN (R) and SAIN (V)

Comparison of model predictions and speed trial results for a group of 32' wooden trawlers. *Fish. Technol*, 7 (2), 1970 : 129–136.

Speed trial results of six 32' wooden stern trawlers built to the same design are analysed to determine the EHP shipfroude number curves in each case and are compared with the model test results of the same design and the corresponding displacement conditions are presented in this communication.

23. BALASUBRAMANYAN (R)

Choice of mechanised fishing boats for the exploitation of the marine fishery resources of the Tamil Nadu Coast. *Seminar on Mariculture and Mechanised Fishing. Dept. of Fisheries. Govt. of Tamil Nadu, Madras.* 1972 : 136–137.

Specially designed and fully equipped small and medium sized boats have special advantages in operating specific types of gear. Lighter vessels with minimum engine horse- power prove to be economical for gill nets. Sturdy and stable fishing boats in the size range of 30' to 60' (9m to 18m) for exploiting areas below 40 fathoms and above 50' for areas beyond 40 fathoms appear to be ideal for economical running and maintenance. For the exploitation of the offshore oceanic stocks of tuna, sail–fish and the like an entirely different type of sturdy vessel most preferably of steel construction in the size range of 90' to 130' will be required. Whenever anchorage and harbour facilities are wanting small and light mechanised beach-landing (surf–boats) crafts have scope for introduction.

24. BALASUBRAMANYAN (R)

Scope of participation by the small scale industries in the programme of construction of mechanised fishing boats in India. *Industrial Seminar on Full Employment for Kerala, Ernakulam Dist. Small Industrial Ass., Ernakulam.* 1973.

The paper is an attempt made with a view to draw the attention of the prospective entrepreneurs of the small industries to the need for their active participation with the development of the boat building industry. Nearly 25 to 30% of the present investment is on the

ancillary items. A list of essential items with details on their probable demand and some useful hints on their production is furnished as a basic guide line, the field of which can be explored further. There is now much scope for the small industries to take up production of these items for which a ready market is always assured within India and outside as well.

25. BALASUBRAMANYAN (R)

Some basic guidelines in the construction of 'Ferrocement' fishing boats. *Seafood Export J.*, 5 (1), 1973 : 1–7.

In choosing 'Ferrocement' as a new material for the future construction of fishing boats in India, the major problems of marine corrosion and organic deterioration are successfully eliminated and a cheaper and simpler method of boat construction is established. Some of the main points for consideration during 'Ferrocement' hull construction are also embodied.

MAINTENANCE

26. BALASUBRAMANYAN (R) and MENON (T R)

Destruction of boat building timbers by marine organisms in the port of Cochin : Pt. 1. Raft tests. *J. Mar. Biol. Ass., (India)*, 5 (2), 1963 : 294–310.

The presence of the various timber destroying marine organisms in the Port of Cochin, their relative abundance throughout the year as well as the degree of resistance possessed by various timber species to such attacks are presented in this paper.

27. BALASUBRAMANYAN (R)

Protection of wooden hulls of fishing boats against marine borers *Proc. Symposium on Marine Paints*, New Delhi 1964.

Experiment revealed that differents samples of the common boat buliding timbers were all infected by marine borers in varying degrees within a period of one year of immersion in the Port of Cochin. The pr tective efficacy of indigenous preparations against marine borer attacks was studied. It was evident that these preparations were not able to resist borer settlement and their further onslaught to a desired extent. In the use of toxic chemicals as wood preservatives that would reliably resist the wood decaying organisms and thereby enhance the natural durability of the boat buliding timber provides a new field of study. Test panels treated with heavy creosote and 'Ascu' exhibited the maximum resistance to wood borers.

28. BALASUBRAMANYAN (R) and RAVINDRAN (K)

Antifouling preperties of 'Fmerald Green' : A preliminary observation, *Proc. Symposium on Marine Paints, Defence R & D Organisation*, New Delhi, 1964.

Observations made on an antifouling composition incorporating 'Emerald Green' a copper arsenic compound, as the toxic pigment are presented in this paper.

The paper also details a study on the reaction of the major fouling organisms to copper arsenic poison in relation to that of the copper compounds present in the commerical antifouling paints.

Exposure tests conducted at different sites showed that the fouling-free life of wooden panels coated with the composition was 6 to 7 months which was

higher compared to the commercial compositions exposed simultaneously. Emerald Green can be incorporated as a satisfactory toxicant in marine paints.

29. BALASUBRAMANYAN (R)

New record on the unusual boring activity of the Pholadid Martesia in the Port of Cochin. *Sci. Cult*, 31 (3), 1965: 155.

During a study on the marine boring organisms in the Port of Cochin, the author came acrossan unsual instance of boring activity of *Martesia striata*, a species of bivalve molluscan wood-borer belonging to the family pholadidae, attacking plastic sheets under prolonged immersion in marine environment which appears to be very unusual and seems to be the first record.

30. BALASUBRAMANYAN (R)

Aluminium alloy as sheathing material for the wooden hulls of fishing boats. *Res. & Ind*, 10 (6), 1965 : 163–165.

The paper describes the application of indigenous aluminium alloys for sheathing the wooden hull of fishing boats. The sheathing procedure, protection of the sheathing by painting, installation of sacrificial anodes and precautions to be taken are discussed.

31. UNNIKRISHNAN NAIR (N)

Marine fouling in Indian waters. *J. Sci Ind. & Res.*, 24 (9), 1965 483–488.

A review of the work on marine fouling in India and else where has been presented. The findings relate to the composition of the fouling community", their quantitaive and qualitative differences, the role of primary film and its significance, the seasonal and ecological succession of biotic communities etc. Environmental factors like temperature, salinity, pollution, turbidity, waves, tides, currents, light, colour, nature and texture of the substratum and abrasion have been raviewed and discussed with particular reference to the conditions prevailing in India. The magnitude of marine fouling in Indian waters and suggestions for future work based on current knowledge have been dealt with.

32. BALASUBRAMANYAN (R)

Experiments and experiences with fibreglass reinforced plastics as a protective sheathing material in fishing boats. *Symposium on Fibreglass Reinforced Plastics*, Madras, 1967

Fibreglass sheathing of wooden hulls as a substitute for the conventional copper plates was studied. Wooden test boards sheathed with fibreglass chopped strands were put to comprehensive tests and their protective efficiency was evaluated. A standard method for the hull sheathing with F R P is presented The fibreglass sheathing is impervious to rot, leak and corrosion and can withstand attack of marine wood borers.

33. BALASUBRAMANYAN (R)

Indigenous substitutes for imported natural resin 'dammar batu'. *Res & Ind.*, 12 (3), 1967 : 165 167.

Surface coating preparations of indigenous resins was found to be as good as those of imported "dammar batu." The impregnation of hot resin prevents moisture changes and enhances the surface hardness of wood, The resin coating was found to be not effective against marine borers. The indigenous resin is a cheap and effective substitute for imported resin in the maintenance of boats and canoes.

34. UNNIKRISHNAN NAIR (N)

Settlement and growth of major fouling organisms in Cochin harbour *Hydrobiologia*, 30 (3-4), 1967: 503-512.

The peculiar hydrographic conditions prevailing in Cochin Harbour and their probable influence in the settlement and growth of fouling organisms are presented.

The settlement and growth of the various fouling groups are very much reduced during the monsoon period. Salinity plays a decisive role in the breeding and subsequent settlement of the larvae of marine foulers. The existance of certain strains of barnacle and encrusting *bryozoans* during the monsoon period is attributed to the gradual acclimatisation. The forms which cannot tolerate the low salinity are eliminated during the monsoon period and the areas left bare by these organisms are found later recolonised by planktonic larvae brought to the site by tidal currents and other movements of the water mass.

35. BALASUBRAMANYAN (R), RAVINDRAN (K), UNNIKRISHNAN NAIR (N) and GOPALAKRISHNA PILLAI (A G)

Protection against borers, foulers and corrosion through the use of aluminium alloy sheating in a marine environment *2nd International Congress on Marine Corrossion and Fouling*, Athens, 1968.

A prototype mechainsed wooden fishing boat of 30' overall length was commissioned and its hull below waterline was fully sheathed with Aluminium Magnesium alloy containing 2% Mg and having a thickness of 22 SWG. Methods for counteracting pithing corrosion, galvanic corrosion, crevice corrosion and deposit attack are discussed. The paper covers the results of three years' observations on the performance of aluminium sheathing for substituting copper sheathing of the hull.

36. GOPALAKRISHNA PILLAI (A G), RAVINDRAN (K) and BALASUBRAMANYAN (R)

On the design and testing of an antifouling paint incorporating copper acetoarsenite. *Paintindia*, 13 (7), 1968 : 28-34.

The paper reports the results of studies on a number of paint formulations using copper acetoarsenite in a partially soluble matrix, composed of modified resin and CNSL.

The design and the subsequent tests led to the formulation of an antifouling paint. Wooden panels coated with this possessed an effective life of nine months under tropical conditions in the Port of Cochin. A suitable antifouling paint formulated with copper acetoarsenite at 35.63% by weight imparts longer fouling free life to wooden panels than the commercial products containing cuprous oxide.

37. RAVINDRAN (K)

Stray current corrosion of copper sheathing and keel cooling pipe of a 36' trawler. *Fish. Technol.*, 5 (2), 1968 : 96-100.

The results of investigations on the cause of corrosion of copper sheathing and keel cooling pipe of a 36' wooden trawler are reported.

Corrosion rates of 2.2 mils and 2.4 mils in case of copper sheets and 2.1 mils and 2.5 mils in case of keel cooler pipe in tropical marine environment under non-aerated and aerated conditions respectively are observed. The accelerated corrosion is attributed to stray electric currents originating from the electrical wiring systems. Normal sources of stray current in wooden boats are indicated and remedial measures suggested.

38. BALASUBRAMANYAN (R)

Biological evaluation of anti-fouling paints. *Paintindia*, 19 (7), 1969 : 19–24.

To study the relative biological efficiency of an experimental paint composition developed by the Institute, test panels coated with it were exposed in the Port of Cochin along with those coated with commercial antifouling paints. The efficiency of the different compositions were assessed by the quality and quantity of the marine sedentary fouling organisms settling on them as compared with nontoxic controls. Two of the paints were further subjected to tests under actual service conditions. The probable life of the different antifouling paints have been evaluated based on the results of the raft exposure and service tests.

39. BALASUBRAMANYAN (R) and GOPALAKRISHNA PILLAI (A G)

Investigations on the utility of cashewnut shell liquid as a surface washing material on wooden fishing boats. *Seminar on Cashew Nut Shell Liquid*, Cochin, 1969.

Results of investigations on CNSL carried out have shown that for timber protection in seawater the toxicity of CNSL has to be further fortified to enhance their resistance to marine borers. CNSL resin as a surface coating on timber surfaces has a better protective value than the untreated oil. Modified CNSL resin could be successfully employed in combination with linseed oil resin as matrix in the antifouling paint formulation.

40. RAVINDRAN (K), GOPALAKRISHNA PILLAI (A G) and BALASUBRAMANYAN (R)

On the development of a ship bottom paint composition using modified cashew nut shell liquid (CNSL). *Seminar on Cashew Nut Shell Liquid*, Cochin, 1969.

This communication deals with the development of an anticorrosive paint formulated with a commercially available CNSL condensation product marketed under the trade name 'SILIX' with pigmentation similar to that of AC 655 of Admiralty. The characteristics and performance of coating are presented. The coating passed the usual tests prescribed for anticorrosive compositions and did not show any blistering or softening on cathodically protected structures. Paint based on oil or oleo-resinous media becomes easily saponified under such conditions. The present composition withstands the alkalinity normally encountered on cathodically protected steel hulls.

41. BALASUBRAMANYAN (R)

Corrosion of steel in the marine environment and its prevention with special reference to trawlers, *Indian Seafoods*, 8 (2), 1970 : 1–6

A review on the behaviour of steel in the marine environment has been made by the author.

The ordinary iron and steel are highly susceptible to corrosion in both coastal

atmosphere and sea- water and yet they have the greatest use because of the factors of cost and important physical properties. Marine corrosion and its prevention are complicated subjects. When signs of rust are detected, preventive measures have to be taken up. The causes of corrosion in fishing boats with a view to suggesting economical preventive measures, material selection, fleet management and service maintenance are some of the subjects dealt with in this paper.

42. BALASUBRAMANYAN (R)

Studies on the pholadid marine wood borer *Martesia striata* (*Linn.*) *Proc. Symposium on Mollusca*, Cochin, 1970 : 707–711.

Specimens of *Martesia striata* from timber samples bearing their infestation have been collected from almost all the Indian harbours and ports as well as all along the coast of India. A number of selected toxic wood preservatives were put to test. *Martesia striata* has been found to tolerate many of the toxic chemicals incorporated into wood and only a heavy loading of 'Creosote' and copper–chrome–arsenic compound could keep the timber blocks free from their settlement. While it spears to be possible to check and keep under control the molluscan wood-boring shipworms by the application of toxic wood preservatives, controlling *Martesia* infestation on submerged timber structures still poses a serious problem which requires further detailed investigations on the physiology of the animal and toxicity studies.

43. BALASUBRAMANYAN (R) and UNNIKRISHNAN NAIR (N)

Fouling by oysters and its prevention. *Proc. Symposium on Mollusca*. Cochin, 1970 : 730–735.

The paper deals with fouling by *Crassostrea sp.* in the Port of Cochin with special reference to its settlement and general life on test blocks, boat hulls and buoys installed for purposes of navigation and mooring. Toxic chemicals like cuprous oxide, copper naphthenate, copper–acetoarsenite, copper – chrome–arsenic compound, pentachlorophenol, 'Dieldrin', and coal–tar and its various derivatives have been tested for their resistance to the settlement of oysters. The study also included the reaction of the settling larvae to different metallic and non-metallic coloured and uncoloured surfaces Though the animals are killed under adverse hydrographical conditions, the accumulated shells on the hulls of fishing boats that cause the undesirable frictional resistance, have to be removed by mechanical means only.

44. BALASUBRAMANYAN (R)

Experiments with fibreglass sheathing as a protection against marine wood-boring organisms. *Fish. Technol.*, 8 (1), 1971 : 60–65.

Investigations on the use of fibreglass sheathing as a substitute for the conventional copper or aluminium alloy on the hulls of modern mechanised fishing boats and the extent of protection that could be obtained by this new sheathing material against marine wood boaring and fouling organisms in the tropical waters of India are presented.

In the Port of Cochin where most of the timber destroying marine wood borers (*Teredinids*, *Pholadids* and Crustaceans except *Limnoria*) are present in large numbers, wooden test panels and marine plywood test boards protected with a sheathing of fibreglass reinforced plastic

have been free from all borer attacks for a period of 52 weeks, while unprotected controls were all attacked heavily within 25 weeks.

45. BALASUBRAMANYAN (R)

Fibreglass reinforced plastic sheathing for wooden fishing boats. *Indian Seafoods*, 8 (4), 1971 : 1–7.

Fibreglass reinforced plastic (FRP) is introduced in boat building industry particularly for the construction of 'All Plastic' fishing boats. In India only small boats and pleasure crafts are made out of FRP. There is plenty of scope for popularising FRP fishing trawlers specially for mass production of standard designs. For reasons of efficiency and economy, a schedule of work was adopted in all prototype studies and the procedures followed have given excellent results. Methods of sheating wooden boat hulls with FRP is described in the communication.

46. BALASUBRAMANYAN (R)

Gel time studies in activation of polyester resins. *Fish. Technol.*, 8 (2), 1971 : 220–222.

Gelling time for polyester resin with varying quantities of catalyst and accelorator were studied and the results are reported.

The normal gelling time of the polyester resins under activation can be varied to some extent suiting the actual working condition by regulating the quantity of accelerator and catalyst. Atmospheric temperature and relative humidity also play an important role both under use and storage.

47. GOPALAKRISHNA PILLAI (A G)

Designing of a single pack wash primer for aluminium surfaces in a marine environment. *Fish. Technol.*, 3 (2), 1971 : 223–226.

Boat builders and aluminium fabricators have been experiencing difficulties in handling the dual pack primer involving extraction, labour and the need for strict vigilance in mixing and application. A new chemical etchant for aluminium surfaces was formulated and its basic characteristics were studied and the results are presented.

Design aspects and comparative performances of different laboratory formulations of wash primers were studied under laboratory and field conditions with reference to scratch hardness, flexibility, stability, resistance to corrosion and adhesiveness. The different formulations of single pack primer tested have shown superiority over double pack wash primers.

48. UNNIKRISHNAN NAIR (N)

Studies on the occurence and growth rates of two intertidal fouling bryozoans namely in the Mattancherry channel of Cochin Harbour, South-West Coast of India, *Fish. Technol.*, 8 (2), 1971 : 174–184.

Occurrence and growth rates of two species in intertidal fouling bryozoans namely *Electra bengalensis* (Stoliczka) and *Electra crustulanta* (Pallas) are presented in this paper.

The former is a typically marine form settling on panels only during the high saline conditions of the premonsoon period and were absent during the low

salinity conditions of the monsoon period while the latter appeared to be a typical brackish water form settling on panels during low saline conditions existing during monsoon and post-monsoon periods and were totally absent during the premonsoon months.

49. BALASUBRAMANYAN (R), UNNIKRISHNAN NAIR (N) and GOPALAKRISHNA PILLAI (A G).

Problem of marine fouling in the coastal waters of India and its economic implications with special reference to fishing fleet management. *3rd International Congress on Marine Corrosion and Fouling, National Bureau of Standards*, Maryland, USA, 1972.

The importance of the fouling problem in India with an economical background is presented in this paper.

In the absence of adequate dry-docking facilities at present, the only way is to enhance the effective life of antifouling paints or bring out a most economical alternative method of preventing fouling. The newer construction materials like FRP, marine quality aluminium and 'Ferrocement' and their exposed surfaces will in no way be free from fouling in Indian waters.

50. GOPALAKRISHNA PILLAI (A G) and UNNIKRISHNAN NAIR (N)

Experimental formulation of an antifouling paint with tributyl tin oxide as toxic pigment. *Fish. Technol.*, 9 (2), 1972: 153-158.

Results of the experimental formulation of an antifouling paint incorporating tributyl tin oxide (TBTO) as toxic pigment are presented.

Of the various resins tested, namely, phenolic, cashewnut shell liquid (CNSL), epoxy, linseed oil with resin and limed resin, the paint composition with TBTO gave critical leaching rate. Acid alkali test showed dissolution of matrix. Accelerated corrosion tests did not reveal any signs of corrosion in panels painted with or without barrier coat. Raft exposure studies indicated that the new formulation could resist fouling accumulation on painted panels for 9 months.

51. UNNIKRISHNAN NAIR (N), GOPALAKRISHNA PILLAI (A G) and BALASUBRAMANYAN (R)

Studies on arsenical creosote as a wood preservative for marine structures : Pt. I, incorporation of arsenic in creosote at various temperatures. *Fish. Technol.*, 9 (1), 1972 : 76-80.

The characteristic dissolution of arsenic in creosote under varying temperatures has been studied.

A detailed survey of the fortification of normal creosote and low temperature creosote with As_2O_3 at 40° C, 50°C, 60°C, 70°C, 80°C and 90°C was carried out. When compared to normal creosote, low temperature creosote has been found to combine more easily with As_2O_3 when temperature was raised from 40 to 90°C. The incorporated arsenic values obtained shows that low temperature creosote with high phenolic content, retains considerably more As_2O_3 and a maximum of 0.218% w/w can be incorporated in low temperature creosote at 90°C.

52. UNNIKRISHNAN NAIR (N), GOPALAKRISHNA PILLAI (A G) and BALASUBRAMANYAN (R).

Studies on arsenical creosote as a wood preservative for marine structure: Pt. II, Observations on leaching corrosion and resistance to borer attack. *Fish. Technol.*, 9 (2), 1972: 126-132.

Essential features of arsenical creosote with special reference to leaching characteristics in sea water, behaviour in contact with metals and resistance to marine borers in tropical waters in India have been studied.

Results showed that aging had very little effect on the preservative. Corrosion of mild steel, galvanised iron, aluminium-magnesium alloy (M 57S) and copper panels in the preservative was found to be negligible. Both normal creosote and low temperature creosote fortified with arsenic trioxide resisted borer damage on wooden panels for a period of over five months in the port of Cochin. The performance of low temperature creosote fortified with arsenic was found to be equally satisfactory when compared to normal creosote fortified in the same manner.

53. BALASUBRAMANYAN (R)

Case history on the phenomenal corrosion of marine propellers in fishing boats. *Fish. Technol.*, 10(1), 1973: 21-23.

Although high tensile brass of copper zinc alloys (Manganese bronze) find extensive use in all marine applications, marine propellers cast out of such an alloy frequently suffer heavy corrosion damages due to dezincification. An interesting case history where a number of propellers have undergone dezincification in the Cochin backwaters is narrated in this paper.

54. BALASUBRAMANYAN (R), UNNIKRISHNAN NAIR (N) and GOPALAKRISHNA PILLAI (A G)

On the importance of ship-bottom fouling by marine organisms: A techno-economic survey. *Fish. Technol.*, 10 (2), 1973: 120-123.

A course of biological studies and investigations on the coastal foulants have revealed quick growth, early maturity, greater facundity and intensive settlement within a short time and resistance to adverse conditions under tropical Indian conditions. A supporting investigation on the hydrographical studies of the aquatic environment brought to light the greater influence of salinity and lesser influence of water temperature on the fouling complex encountered. Periodical coating with antifouling paint on the hulls while the boats are on the docks, is the only preventive measure, the Indian fishing fleet is adopting at present. Studies on the biological evaluation of commercial antifouling paints have indicated much scope for their improvement as regards design, formulation, toxic loading and actual performance.

55. RAVINDRAN (K) and BALASUBRAMANYAN (R)

Cathodic protection of the hulls of fishing trawlers in India. *Proc. Symposium on Cathodic Protection, Defence Research and Development Organisation*, Kanpur, 1973 : 168-171.

Corrosion problems encountered at the stern quarter of metallic sheathed wooden boats, copper sheathing, aluminium sheathing and ferrocement boats are discussed. The criteria for cathodic protection of copper and Al-Mg alloy are reported. These metals are protected at -600 mV Ag/AgCl and -950 mV SCE respectively.

56. UNNIKRISHNAN NAIR (N)

Observations on the fouling characteristics of four bryozoans in Cochin harbour. *Fish. Technol.*, 10 (1) 1973: 61-65.

While conducting studies on fouling organisms at Cochin harbour the author observed the settlement of four species of bryozoans.

The occurrence of the four species of bryozoans under study showed that *Electra crustulanta* PALLAS and *Victorella pavida* KENT are brackish water forms. *Electra bengalensis Stoliczka* and *Schisoporella cochinensis* are typical marine forms. It is interesting to note the seasonal succession of these species in Cochin harbour corresponds to the distribution of salinity in this area.

57. BALASUBRAMANYAN (R)
Choice of ship-bottom paints for fishing boats. *Seafood Export J.*, 6 (1), 1974: 155-122.

Ship bottom protective coating system involves surface preparation, application of suitable primers, application of anticorrosive paints and the final application of antifouling paints. The application of primers, their composition and constituents were studied from the point of view of marine c rrosion and bio-degradation of material in sea water.

58. RAVINDRAN (K), HEERMAN (L) and VAN SIMAEYS (L)

Anodic behaviour of lead in acid sulphate solutions : Influence of copper and cobalt ions. *Bull Soc. Chim. Belg.*, 83, 1974 : 173-184.

The anodic behavior of lead has been studied at $Pb/PbSo_4/PbO_2$ potentials in sulphuric acid solutions in presence of copper and coblat ions by galvanostatic and potentiokinetic methods. The presence of cobalt ions has been observed to exert a beneficial effect in reducing the anodic dissolution of lead. Anodic corrosion products, in function of cations in solution have been analysed by X-ray diffraction technique. A schematic model of passivated lead anode in presence of cobalt ions has been proposed.

59. RAVINDRAN (K) and BALASUBRAMANYAN (R)

Problems associated with over protection of fishing trawlers against sea water corrosion and fouling. *Fish. Technol.*, 12 (2), 1975: 94-97.

The paper attempts to limelight the problems associated with the over protection of boat hulls vis-a-vis the improper use of protective measures against marine corrosion and fouling.

The effects of excess current density on anticorrosive and antifouling coating are discussed. Depending on the current density and availability of dissolved oxygen the cathodic reaction would result in the formation of hydrogen or hydroxyl ions.

60. RAVINDRAN (K), HEERMAN (L) and VAN SIMAEYS (L)

Anodic behaviour of lead in acid sulphate solutions : Influence of Manganese ions and electrochemical oxidation of manganese ions at lead anodes. *Bull. Soc. Chim. Belg.*, 84, 1975 : 83-90.

Results concerning the influence of manganous ions, either singly or in combination with lead in acid sulphate solution are reported. The corrosion of lead is much less when it is compared to

media containing only copper and cobalt ions. This fact has been corroborated by result obtained by the potentiokinetic method. Results on the electrochemical oxidation of manganous ions at lead anodes in presence of cobalt ions are also described.

61. GOPALAKRISHNA PILLAI (A G)

Analytical study of the sea water slime with reference to bacterial flora. *Fish. Technol.*, 14 (1), 1977 : 78-83.

A detailed study of the primary film of slime with reference to the bacterial flora, its quality and quantity as observed on different material surfaces exposed to sea water is carried out. A correlation has been established between bacteria and slime deposited on different surfaces.

The quantity of slime collected at different intervals from the experiments, shows that the settlement is predominant on wooden panel and varies from 1.12 mg/cm^2 to 5.2 mg/cm^2 when examined after 2hrs. and 7 days respectively. The reason for the greater quantity of slime accumulated wooden panel is the non-toxic nature of the substratum. The constituents of the slime film were analysed for organic matter, in soluble ash and salt content. Slime film deposits on wood contains 27% organic matter (dry weight).

62. RAVINDRAN (K), SHAHUL HAMEED (M) and BALASUBRAMANYAN (R)

Effect of electrical polarisation on the initial stages of settlement of marine fouling organisms. *Symposium on Protection of Materials in the sea*, Bombay, 1977.

An attempt has been made to evaluate whether electrical polarisation of 100 to 209 millivolt has any influence on the initial stages of settlement of marine fouling organisms on metal panels of aluminium, mild steel, brass, lead and stainless steel immersed in the backwaters of Cochin harbour. Studies which extendes over a period of 40 days have revealed that the quantum of settlement was influenced by the electrical polarisation. In all cases accumulation of fouling complex on control panels was observed to be more in comparison to polarised metal panels subjected to the study. The effect was more pronounced in the case of aluminium and less with brass. Results may provide some guidelines for the design of second generation antifouling paints.

63. RAVINDRAN (K)

Dolphins' secret: A clue for reduction surface roughness of ships hulls. *Indian Fish. Bull.*, University of Cochin, Cochin, 1979: 61-64.

Efforts made in the design of antifouling paints employing organometallic compounds, notably organotin, have resulted in long term antifouling protection extending for 2 to 3 years. Following closely on the fast swimming behaviour of dolphins, a unique phenomenon, a possible method of minimising the adverse effects of hull roughness would be the use of a water expanding hydrophilic top coat. Research led to the development of a series of polymers either-linear or cross-linked derived from hydroxyalkyl acrylate and methacrylate monomers. An advance in this area has been made recently by Hempels' marine paints with the introduction of their new marine coating incorporating a hydrophilic acrylic resin HYDRON DYNAMIC. This when applied over AF coating, it is claimed imparts advanta-

ges like significant reduction of skin friction resulting in higher speed and less fuel consumption, controls leaching of bio-active material in a programmed way resulting in prolonged antifouling effect.

64. BALASUBRAMANYAN (R)

Fishing boat maintenance: Some basic guide lines, *Fisherman*, 1 (2), 1980 : 21-23.

The marine envi onment in which the fishing fleet is operated is very aggressive and hostile and as such boats are subject to periodic examination, appraisal and maintenance to keep them in fit condition. The author, in this paper, has given a recommended maintenance schedule for fishing boats.

65. RAVINDRAN (K), UNNIKRISHNAN NAIR (N) and GOPALAKRISHNA PILLAI (A G)

Cost reduction in maintenance of fishing boats. *Fisherman*, 1 (2), 1980: 37-41.

Mechanised fishing boats collectively represent a huge capital investment. Selection of materials and proper maintenance are all the more important. Various agencies of deterioration such as corrosion, fouling and fungal infestation are brought out in detail. The paper also discusses the selection of materials, prevention of corrosion by cathodic protection, prevention of fungal deterioration of wooden counterparts by resorting to suitable chemical preservative treatments and prevention of fouling by the application of antifouling paints. The cost of labour involved for repairs and maintenance and the rate of return are also highlighted.

GEAR TECHNOLOGY

MATERIALS

66. GOPALAN NAYAR (S)

Preliminary studies on the characteristics of coir twines. *Indian J. Fish.*, 6, (2), 1959 : 410-415.

The studies on the characteristics of different grades of coir twines were undertaken with a view to evaluate the qualities of the different grades of coir twines as to facilitate determination of their utility as a fishing gear material.

Unlike other fibres of vegetable origin, the coir twines lose breaking strength by 5-24% in the wet condition.

67. KURIYAN (G K) and CECILY (P J)

Common characteristics of cotton fishing net twines : A preliminary account. *Indian J. Fish.*, 6 (2), 1959 : 399-406.

The common characteristics of soft twisted cotton fishing net twines are enumerated. The interrelationship between the mass, diameter, breaking strength, breaking stretch and the effect of knots have been studied.

68. MIYAMOTO (H)

Suggestions for preservation of fishing nets. *Indian Fish. Bull.*, 6 (3), 1959 : 44-46.

A method of preserving fish net twines by applying a mixture of coat tar and kerosene subsequent to tanning treatment is described. The method is suitable for trawl net, stake net and other types of gear which are immersed in water for longer periods. As the weight of net increases by this treatment, it is not recommended for gill nets and the like.

69. MIYAMOTO (H) and SHARIFF (A T)

Preliminary investigations on sunhemp twine as a fishing net material. *Indian J. Fish.*, 6(2), 1959 : 389-398.

Preliminary investigations carried out on sun hemp net twines to assess physical properties such as breaking strength, elongation in dry and wet conditions and susceptibility of the material to rotting during submersion in water are presented.

70. MIYAMOTO (H) and SHARIFF (A T)

Experiments on fishing net preservation. *Indian J. Fish.*, 6 (1), 1959: 145-185.

Preservation experiments conducted on sun hemp fish net twines are presented. Preservatives include, tannin, its fixation and chemical preservatives. An evalution procedure is given based on number of days taken to reduce 50% of original strength under continuous immersion.

71. GOPALAN NAIR (S) and MANGAYYA NAIDU (R)

Note on the preservative qualities of certain indigenous fish net preservatives on coir twines. *Sci. Cult.*, 26, 1960. 271-272.

The results of preliminary observations made on the comparative effect of different gear preservatives on coir twines are embodied.

The results indicate that coir webbings and ropes, which have to be in water for long periods as in the case of stake nets, bag nets etc. if given a tannin + coal tar treatment prolong the life of the gear nearly three times.

72. KURIYAN (G K) and CECILY (P J)

Common characteristics of cotton fishing net twines : Experiments Series II. *Indian J Fish.*, 7 (2), 1960 : 471-482.

The paper describes the results of experiments carried out to evaluate the common characteristics of hard twisted cotton fish net twines.

The samples were found to be fairly well twisted taking into consideration the diameter and the number of twist. It was evident that the breaking strength is proportional to the number of threads and to the square of the diameter of the twines. The breaking stretch of twines increased with twist hardness. The loss in strength of the twines while made into reef knots and trawl knots was also studied.

73. KURIYAN (G K) and RADHALAKSHMI (K)

Comparative study of certain characteristics of the common vegetable fibre twines for fishing nets. *Indian J. Fish.*, 7 (2), 1960 : 448-457.

The paper deals with the preliminary study conducted for evaluating the

common characteristics of fish net twines such as cotton, sun hemp, Italian hemp, sisal, manila, and coir.

Italian hemp was found to be nearly twice stronger than the sun hemp. Except in the case of coir, the strength of twines showed an increase in strength in the wet condition. In all the materials studied the stretch when wet was found to be more than dry.

74. SATYANARAYANA (A V V)

Preliminary studies of certain characteristics of spherical fishing floats. *Indian J. Fish.*, 7 (2) 1960 : 483–495.

The characteristic features that contribute to the relative efficieny of a float are extra buoyancy, reduction of the buoyant force due to absorption of water, capacity to withstand the different water pressures at various depths; and strength against shocks, abrasion and rotting. A comparative study of floats made of glass, aluminium and plastic of different sizes and shapes is presented.

75. KURIYAN (G K) and CECILY (P J)

Effect of boiling fishing net twines. *Curr. Sci.*, 1961: 319–20

To ascertain the possible effect of boiling on the resultant strength, netting twines of cotton, sun hemp and Italian hemp were immersed in boiling water for different periods and their strength determined after such exposure. The strength of the twines was not affected by boiling up to 120 minutes.

76. KURIYAN (G K) and GOPALAN NAYAR (S)

Common Indian fishing gear preservatives: A General account. *J. Asiatic. Soc.*, 3 (1), 1961 : 21–37.

The indigenous preservatives used in different localities are listed along with the methods of treatment followed by the fishermen.

77. KURIYAN (G K) and SATYANARAYANA (A V V)

General account of the wooden floating materials used for fishing nets in India. *J. Timber Dryer's & Preserver's Ass. (India)*, 7 (4), 1961: 13–26.

Samples of different floats were collected from maritime States and the chief characters like the general measurements, mass, volume and extra buoyancy were studied. In wooden floats the quality which demands specific attention is the loss of buoyancy due to continuous immersion, resistance to varying water pressures, friction and resistance to decay or rotting.

78. GEORGE (N A) and RADHALAKSHMI (K)

Preliminary studies on the preservation of sunhemp fishing net twines. *Indian J. Fish.*, 9 (1) B, 1962 : 23–31.

Preliminary studies undertaken for the preservation of sunhemp twines following continuous immersion method are discussed. The methods of preservation tried were tanning, fixation of tannin by using oxidising agents, coal tar coating on tannin fixed twines, chemical preservatives such as garnol, cunilate, marstein, B. C. green cuprional, net life green etc. The relative merits and demerits of different types of preservation methods are given in detail.

79. GOPALAN NAYAR (S)

Studies on the effectiveness of certain chemical preservatives on cotton twines. *Indian. J. Fish.*, 9 (1) B, 1962 : 47-51.

Effectiveness of some of the chemical preservatives produced within the country are discussed in detail.

The percentage impregnation was found to be lowest in the case of creosote while it was highest for coal/tar-creosote combination. The progress of rotting of twines treated with commercial fish net preservatives and creosote was rapid compared to twines treated with coal-tar + kerosene and coal/tar + creosote combinations.

The effectiveness of the various preservatives was determined on the criterion of the time taken by the untreated and treated twines to lose half their orginal breaking strength.

80. GOPALAN NAYAR (S), GEORGE (N A) and NARAYANAN (K P).

Studies on the preservation of sisal twines, *Indian J. Fish.*, 9 (1) B, 1962 : 16-22.

The effect of four varieties of tannin preservatives treated in different methods and nine varieties of chemical preservatives on sisal twines have been studied. Tannin preservatives fixed by copper sulphate and ammonia showed better preservetive qualities than tanning alone, followed by tannin+coal tar and tannin fixed+ coal tar in order. Chemical preservatives showed almost equal preservative effects as tannin fixed preservatives.

81. GOPALAN NAYAR (S) and MANGAYYA NAIDU (R)

Preservation experiments on coir twines. *Indian J. Fish.*, 9 (1) B, 1962 : 52-57.

The highest effectiveness is imparted by cutch fixed + coal tar treatment. This treatment also imparts the highest percentage impregnation. When the effectiveness of this treatment is compared with Kalasam fixed + Coal tar treatment, the difference in the effectiveness of the two methods is very negligible. It can reasonably be inferred that 'Kalasam fixed + Coal tar treatment ensures maximum effectiveness to gear fabricated with coir.

82. GOPALAN NAYAR (S) and MANGAYYA NAIDU (R)

Studies on the preservations of manila twines. *Indian* J. *Fish.*, 9 (1) B, 1962: 37-46.

The communication deals with the evaluation of the effectiveness of various indigenous and chemical fishnet preservatives on manila twines and the attempts made by the authors to evolve a suitable preservative for this material.

83. GOPALAN NAYAR (S) and VANAJA (M)

Studies on the efficacy of chemical preservatives on coir twines. *Indian* J. Fish., 9 (1) B, 1962: 32-36.

The effect of copper based chemical preservation on coir twines is discussed. The effectiveness and impregnation of the different preservatives on coir twines were mo e or less similar to that of cotton, sunhemp, sisal and manila. The coir twines treated with B. C. green cuprinol deteriorated at a slower rate when compared to other preservatives,

84. KURIYAN (G K) and CECILY (P J)

Characteristics of cotton twines of 20 count yarn for fishing nets. *Indian Fish. Bull.*, 9 (3), 1962 : 11-14.

Cotton twines made of basic 20 count yarn is the common material used in India for the fabrication of fish nets by local fishermen. The majority of the twines taken for analysis were hand-made. The twines used for fabrication of gill nets for the capture of pomfret, hilsa and seer were analysed for physical characteristics, the details of which are presented in this communication.

85. KURIYAN (G K), GOPALAN NAYAR (G) and VANAJA (M)

Experiments on preservation of fishing net twines. *Indian Fish. Bull.*, 9 (3), 1962 : 31 43.

In a tropical country like India, where high temperature prevails, the rotting activity is relatively rapid. The need for proper preservation for retardation of the process of bacterial action on the vegetable fibre twine, therefore, still remains an important problem from the economic stand point. Both organic and chemical preservatives are in vogue for treatment of fishing nets. Experiments on preservation of fishing net twines are summarised in this communication.

86. KURIYAN (G K) and RADHALAKSHMY (K)

Hemp twines for fishing nets. *Indian Fish. Bull.*, 9 (3), 1962 : 15-21.

The paper deals with the characteristics of hemp twines used for fabrication of fish nets. Samples of hemp yarns supplied by traders as well as those indigenously used by fishermen were analysed for their physical properties. It was found that if proper grading and standards are adhered to in twine construction, it may be possible to produce Indian hemp twines of superior quality.

87. MIYAMOTO (Hideaki), KURIYAN (G K) and CECILY (P J)

Comparative account of the rotting resistance of netting twines of fibres of vegetable origin. *Bull. Jap. Soc. Sci. Fish*, 28 (7), 1962 : 655-663.

The resistance to rotting of the principal fishing gear materials of vegetable origin used in India are discussed. Cotton, sun hemp, Italian hemp, sisal, manila and coir twines of varying diameters were immersed in Cochin backwaters and their course of rotting was determined with respect to the kind of material and thickness of twines.

88. SATYANARAYANA (A V V) and KURIYAN (G K)

On the characters of fishing floats : *Indian. Fish. Bull.*, 9 (3), 1962 : 22-30.

Pieces of light wood available locally are the traditional floating materials used by the indigenous fisherman for their nets. In recent years, howerver, manufacture of glass, aluminium alloy and synthetic floats within the country is gaining popularity particularly to meet the needs of modern types of fishing gear from mechanised boats. The paper gives some of the characteristics of the fishing floats and their pressure resistance qualities.

89. KURIYAN (G K) and NAYAR (S G)

Method of preservation of cotton net twines. *Proc. Indo-Pacif. Fish. Coun., Curr. Aff. Bull.*, 38, 1963: 6-8.

The paper embodies some of the methods evolved for preservation of cotton fishing nets. The recommended methods for tannin treatment, tannin fixation and subsequent treatment with coal tar on tanned nets are described. The different classes of nets for which these methods would be useful are indicated.

90. VANAJA (M)

Note on the effectiveness of a combination treatment of half cutch and half bark on cotton fish net twines. *Sci. Cult.*, 29 (7), 1963 : 365-366.

The conventional method used by the majority of Indian fishermen for treatment of cotton nets is to use extract of tannin from barks of various trees. The effect of a combination method by using half cutch and half bark from tanning yielding treeshas been discussed.

91. RADHALAKSHMI (K)

Method of estimation of the weight of fish net webbing. *Indian J. Fish.*, 11 (2) B, 1964: 15-21

An empirical formula for the estimation of the weight of webbing was worked out by the author in relation to the number of meshes, twine size and mesh size. The development of the formula, its verification and application are also described. The formula was applied to some of the webbings prepared for fabrication of nets and the suitability was also checked.

92. KURIYAN (G K)

Nylon for fishing net. *Seafood Export.* J. 1 (6) 1969 : 1-3.

Nylon yarn is made under three principal forms viz. continuous multifilament, continuous monofilament and staple fibre. Nylon made in the form of continuous multifilament is extensively used in this country for fabrication of gill nets. Recently, however, there has been increasing interest in the use of nylon for trawls.

93. RADHALAKSHMI (K) and KURIYAN (G K)

Experiment on preservation and weathering of net twines. *Fish. Technol.*, 6 (2), 1969 : 108-116.

The course of weathering and effect of continuous immersion in water of synthetic fibre twines have been detailed in this communication.

The two test sites selected for the studies were Cochin backwaters in the tropical region and Cuxhaven in the temperate zone. The effectiveness of various preservation techniques for protection of fish nets have been discussed at two different test sites.

94. BALASUBRAMANYAN (R)

Note on the method of reconditioning unserviceab e steel otter doors with fibreglass sheathing. *Fish. Technol.*, 8 (2), 1971 : 228-229

Considering the present scarcity and restricted supply of mild steel, the high initial investment on the steel otter doors and their high rates of corrosion under use in a tropical marine environment (6 miles and above per year), a

suitable remedial measure has been worked out which has brought to light the possibility of raconditioning the corroded steel otter doors with layers of FRP.

95. CECILY (P J) and KUNJAPPAN (M K)

Preservation of cotton fish net twines by tanning : Optimum concentration of tanning bath. *Fish. Technol.*, 8 (2), 1971 : 156-166.

Although tannin preservation is quite common, the preservation methods so far conducted do not indicate the relative effectiveness of the preservative both with respect to the tannin content and type of tannin present in the raw material. The concentration of tannins extracted from various sources required to impart optimum preservative effect to the net were worked out and the results are presented.

96. SATYANARAYANA (A V V) and KURIYAN (G K)

Investigations on wooden floating materials: The loss of buoyancy under continuous immersion in water and the rate of its redemption by drying. *Fish. Technol*, 9 (2), 1972: 139-152.

The paper deals with the important characteristics of some of the chief wooden floating materials used in the West coast of India. The results obtained in the relation between the percentage loss of buoyancy of different fishing floats made of different materials under varying pariods of immersion in water and the rate of its redemption by drying are detailed.

97. CECILY (P J) and KUNJAPPAN (M K)

Preservation of cotton fish net twines by tanning: II-Fixation of Tannin. *Fish. Technol.*, 10 (1), 1973: 24-32.

The behaviour of oxidising agents like potassium dichromate and copper sulphate as fixatives is studied.

The effectiveness of tannin preservation could considerably be enhanced by following fixation technique. The pliability, strength and stretch of the twines were found to be unaffected by the process.

98. RADHALAKSHMY (K) and GOPALAN NAYAR (S)

Synthetic fibres for fishing gear. *Fish. Technol.*, 10 (2), 1973: 142-165.

The communication is a review on the properties of the variety of synthetic fibres that have been successfully used in fishing nets. An attempt has been made to study the comparative characteristics of synthetic fibres introduced in India.

LINES

99. DESHPANDE (S D)

On the results of fishing experiments with trolling gear. *All India Conference of Fishing Gear Technologists, Veraval*, 1961.

Preliminary experiments conducted for catching seer fishes (*Scomberomorus sp.*) using trolling lines are presented.

100. BALASUBRAMANYAN (R)

On the use of different natural baits for sea fishing in India. *Fish. Technol.*, 1 (1), 1964:41.

Rod and line, head line, trolling line, and fish traps are the different types of fishing gears wherein suitable fish baits are employed with a view to lure the catch.

Luring of fish with baited hooks is an important method of commercial sea fishing that requires special attention in India. It was observed that the size of hook, the type of bait, the location of fishing ground and the methods of operation have some striking influence on the fish catch.

101. BALASUBRAMANYAN (R)

Preliminary experiments to evaluate the relative efficiency of different natural baits in line fishing. *Fish. Technol.*, 1(1), 1964: 80

A series of experimental hand line fishing operations were conducted off the Madras coast employing five different types of natural fish baits. A comparative study on the catching efficiency of the different natural fish baits was made based on fishing trials using different types of baits.

102. DESHPANDE (S D) and SIVAN (T M)

On the troll line investigations off Cochin during five fishing seasons. Investigations during 1960-61 and 1961-62 seasons. *Fish. Technol.*, 6 (1), 1969 : 26-35

Observations on the effective trolling speed for enticing seer and tunny indicated that a speed between 4 and 6 knots was reasonably effective. Maximum catches were recorded when the length of the line was between 18.3 m and 36.5 m. Whale bone jig lure was found to be extremely effective for both tunny and seer. White and green coloured feather jigs and jigs with combination of red and white feathers landed good catch. Red and yellow coloured feather jigs were next in order of efficiency.

103. SIVAN (T M) and APPUKKUTTA PANICKER (P)

On the troll line investigation off Cochin during five fishing seasons: Part II-Investigations during 1963-64 season *Fish. Technol.*, 6 (2), 1969: 117-119.

The investigations were mainly directed towards elucidation of the selective action of trolling lures. Feather jigs, baffalo horn jigs, stainless steel jigs, Japanese whale bone jigs and plastic jigs were selected White feather jig was found to be the most effective than buffalo horn, stainless steel, Japanese whalebone and plastic jigs following in order. White feather jig was preferred by the fishes of all length groups except those of 80 to 110 cm where as stainless steel showed its superiority over buffalo horn, whale bone and plastic jigs.

104. DESHPANDE (S D), RAMA RAO (S V S) and SIVAN (T M)

On the results of preliminary fishing trails with shark long lines in Veraval waters. *Fish. Technol.*, 7 (2,) 1970: 150-157.

With a view to evolving a cheap and

effective long line gear for capture of sharks and to asses the relative efficiency of various baits, experimental fishing trials were undertaken.

Three varieties of sharks viz. *Carcharias sp.*, *Gafeocerdo sp.*, and *Zyaqaena sp.*, were landed and their percentage in the total catch worked out to 55%, 35% and 9% respectively. Amongst nine different types of baits used *Chirocentrus dorab* landed maximum catch and was effective in capturing all the three varieties of sharks

105. SUBRAMONIA PILLAI (N), MANOHARADOSS (R S) and SHAHUL HAMEED (M)

On the troll line investigations off Cochin during five fishing seasons : Investigations during 1965-66 and 1966-67 seasons. *Fish. Technol.*, 7 (1) 1970: 20-22.

Investigations were carried out with a view to exploring the possibility of troll line operations on commercial basis and to study the effect of certain meteriological factors on catch.

106. SUBRAMONIA PILLAI (N), MANOHARADOSS (R S) and SULOCHANAN (P)

Standardisation of specifications for different trolling lures. *Fish. Technol.*, 9 (1), 1972 : 68-75.

Fishing operations carried out with buffalo horn, wooden and galvanised iron jigs of different specification rigged up in troll lines revealed that jigs of 12.5 cm length having 60 g wt. to be superior to those of other specifications in catching seer fish.

107. KARTHA (K N), DESHPANDE (S D) and RAMARAO (S V S)

On the results of bottom drift long lines operated off Veraval with particular reference to selective action of baits and hooks used. *Fish. Technol.*, 10 (2), 1973 : 105-109.

The communication deals with the results obtained during field operations with bottom drift long lines operated off Veraval at depths ranging from 13 to 36 m. Taking catch per hundred hooks as a unit for comparison it was observed that 'Dhoma' among the three baits and hook No. 5 among four types of hook used were most effective for capture of predatory fishes.

GILL NETS

108. BALASUBRAMANYAN (R), SATYANARAYANA (A V V) and SADANANDAN (K A)

Preliminary account of the experimental rocklobster fishing conducted along the south-west coast of India with bottom set gill nets. *Indian J. Fish.*, 7 (2), 1960 : 407-422.

Four species of rock lobsters belonging to the genus Panulirus have been hitherto recorded from Indian waters. In the south-west coast season commences from the month of November and extends up to March of the succeeding year. The preliminary experiments conducted on the south-west coast of Peninsular India for the introduction of a new fishing gear for rock lobsters have been detailed.

109 BALASUBRAMANYAN (R), SATYANARAYANA (A V V) and SADANANDAN (K A)

Further account of the rock lobster fishing experiments with bottom set gill nets. *Indian J. Fish.*, 8 (1), 1961 : 269–290.

Attempts have been made to assess the probable extent of lobster fishing grounds in four centres viz. Quilon, Varkala, Vizhingam. Colachal–Muttam. The model size and wt. of lobsters at all the four centres were 25 cm and 0.6 Kg respectively. Regarding the availability of lobsters with respect to depth, majority (about 86%) were caught from depths ranging from 3 to 7 m.

110. DESHPANDE (S D)

Account of 'Dara' (*Polydactylus indicus* shaw): Fishery of the Bombay coast with particular reference to the fishing method by bottom–drift nets. *Indo-Pac if., Fish. Coun., Occ.* Pap. 63/7,1962.

The experiments and observations carried out by the author at various fishing grounds along the Bombay coast have revealed the efficiency of 'Waghra Jal' for the capture of 'Dara' from the inshore waters. Due to bottom dwelling habits of 'Dara' the possibilities of introducing modern gear like otter and bull trawl nets are more. The present commercial aspects of the fishery and the possibilities of their future development have been drawn up.

111. SATYANARAYANA (A V V) and SADANANDAN (K A)

'Chala Vala' encircling gill nets for sardines and mackerels of the Kerala coast with special reference to their design and construction. *Indian J. Fish.*, 9 (2) B, 1962: 145-153.

In view of the importance of the essential technological features pertaining to the design and construction for determining the relative efficiency of the gear a survey of the indigenous gill nets of the Kerala coast, with particular reference to chala vala was undertaken and the results of the survey are incorporated.

112. SATYANARAYANA (A V V) and SADANANDAN (K A)

Design and operation of bottom set gill nets for lobster. *Indian Fish. Bull.*, 9 (4), 1962 : 1–4.

Lobsters contribute to a fairly lucrative fishery on the south-west coast of India. A new design of bottom set gill net for the capture of lobsters and the results of operation of the net have been discussed.

113. JOSEPH (K M) and SEBASTIAN (A V)

Effect of mesh size on the fishing efficiency of sardine gill nets. *Fish. Technol.*, 1 (2), 1964: 180–182.

The paper reviews the results of preliminary studies undertaken by the authors on the effect of different mesh sizes on the out put of sardine gill nets along the Kerala coast.

114. SULOCHANAN (P) and KRISHNA RAO (K)

On the vertical distribution of silver pomfret (*Pampus argenteus Euphr.*) in the bottom drift gill

nets off Veraval and Porbander. *Indian J. Fish.*, 7 (1) B 1967: 9–14.

The optimum depth of the webbing required for bottom drift gill net for silver pomfrets was ascertained by studying the vertical distribution of the silver pomfrets in the bottom drift gill nets operated off Veraval and Porbander regions. The results obtained along with certain suggestions with regard to constructional and operational aspects of the gear are presented.

115. SULOCHANAN (P), GEORGE (V C) and NAIDU (R M)

Experimental fishing in Hirakud reservoir, Orissa (1965-67). *Fish. Technol.*, 5 (2), 1968: 81–95.

Study on the comparative efficiency of the 3 different types of set gill nets showed the frame nets to be more effective than the vertical line net and simple gill net in the expolitation of the Hirakud Reservoir Fishery. Even though the cost of frame net is more than that of the vertical line net and simple gill net, the returns are observed to be tangible. Probable line in furthering the investigations to determine the optimum parameters for framing the net are also indicated.

116. GOPALAN NAYAR (S), SHAHUL HAMEED (M) and VARGHESE (M D)

Experimental fishing in Gandhisagar reservoir, Madhya Pradesh. *Seminar on Ecology and Fisheries of Fresh water Reservoir*, CIFRI, Barrackpore, 1969.

Gill nets of the mesh bar in the range of 45 mm to 55 mm were found to be effective for the exploitation of *Labeo diplostoma*, the major fishery of the Gobindsagar reservoir. Exploratory fishing operations conducted in the reservoir showed that the middle reaches of the reservoir are more productive during summer months. During summer large fish concentrations were odserved in the upper reaches of the reservoir.

117. KURIYAN (G K)

Fishing methods in freshwater reservoirs of India. *All India Coordinated Project for Ecology & Fisheries of Freshwater Reservoirs*, Calcutta, 1971.

The presence of numerous underwater obstructions limits the use of active gear in most of the Indian reservoirs. Passive gear like the set gill nets are apparently the only types possible. After experimental studies in Mettur, Krishnaraja sagar and Tungabhadra reserviors, two designs of gill nets namely, Sebul No.1 and No. II are found to be suitable for commercial exploitation of predominant size groups of these reservoirs. Comparative studies with the three types of nets namely simple gill net, vertical line net and framed net in the Hiracud reservoir have shown the superiority of framed nets over the others.

118. MATHAI (T Joseph), ABRAHAM (Rajan) SULOCHANAN (P) and SADANANDAN (K A)

Preliminary observations on the lunar and tidal influence on the catches of seer by gill nets. *Fish. Technol.*, 8 (1), 1971: 65 68

The authors have made an attempt to study the lunar and tidal influences on the catch of seer and certain preliminary observations are presented.

There exists a significant relationship between the catch of seer and the lunar phase and the tidal rhythum. The moon is not the only factor which affects the seer landings. The best period for the efficient exploitation of seer is darker nights with low tide.

119. MATHAI (T Joseph) and GEORGE (N A)

Note on the comparative catch efficiency of nylon over cotton gill nets in reservoir fishing. *Fish. Technol.*, 9 (1), 1972 : 81–82.

The results of experiments conducted at Gobindsagar reservoir on the relative efficiency of nylon gill nets over cotton are incorporated under this communication. It was found that in nylon nets the catch was 9 times more by weight and 7.6 times more by number than cotton nets, per 100 sq. m of webbing.

120. NAIDU (R M) and GEORGE (V C)

Fishing experiments with frame nets in Hirakud Reservoir. Orissa. *Fish.* Technol. 9 (1), 1972 : 31–33.

The results of experiments conducted in Hirakud Reservoir with nets having different frame sizes are incorporated in this paper.

121. GEORGE (V C) NAIDU (R M) and KUNJIPALU (K K)

Exploratory fishing experiments in Hirakud Reservoir, Orissa State (1967–70). *Fish., Technol.* 10(1), 1973 : 71-78.

The paper incorporates the results of investigations carried out in the Hirakud reservoir, with a view to chart out different fishing grounds, their shifting according to seasons and the relative abundance of the different species.

Suitable areas for fishing have been located in the middle and upper regions of Mahanadi course of Hirakud reservoir. In the former the suitable period is during summer and the beginning of monsoons and in the latter summer and winter months. The fishery of the reservoir is contributed by four species namely *Silondia silondia, Labeo fimbriatus, Cirrhina mirga'a and Catla catla.*

122. KURIYAN (G K)

Fishing gear in freshwater reservoirs of India, *Fish. Technol.*, 10 (1), 1973: 1–5

Selection of an appropriate mesh size will depend upon the predominant size group of commercially dominant species of fish in the reservoir. Comparative studies with the three types of nets namely simple gill net, vertical line net and framed net in the Hiracud reservoir have shown the apparent, superiority of framed nets. The increase in catch recorded was 1.4 to 4.76 times. The net with 1.75 m frame was found to be superior over the others. In Gobindsagar reservoir monofilament gill nets were found to be better than the nets made with twines of multifilament yarn.

123. GEORGE (N A), KHAN (A A) and PANDEY (O P)

Catch efficiency and selective action of coloured gill nets. *Fish. Technol.*, 12 (1) 1975 : 60–63.

The authors have attempted to evaluate the comparative catch efficiency of gill nets of four shades viz. yellow, orange,

green and blue over the colourless ones by conducting fishing experiments in Gobindsagar reservoir. Preference shown to colours by the four major species of fishes of the raservoir was also studied.

124. KHAN (A A), GEORGE (N A), and PANDEY (O P)

On the fishing power of monofilament and multifilament gill nets. *Fish. Technol.*, 12 (1) 1975: 64–69.

The authors have discussed the results of comparative fishing conducted in Gobindsagar reservoir with simple monofilament and multifilament gill nets. The experiments were conducted both in clear and turbid water. In both these water masses, the monofilament gill net has been found to be more efficient.

125. SULOCHANAN (P), SADANANDAN (K A), MATHAI (T Joseph) and ABBAS (M syed)

Selectivity of gill nets for *Seomberomorus commersoni Fish., Technol.*, 12 (1), 1975 : 52–59.

Selectivity of gill nets for *S. commersoni* was studied with nets made of four different mesh sizes fabricated with four different specifications of nylon twines. Fishing operations were conducted off Cochin. The commercially significant size group of *S. commersoni* was found to fall in the length range of 850–950 mm.

The optimum mesh size required for the capture of this group of *S. commersoni* was estimated as 76 mm. bar in nylon twines 210/12/3. The relationship between the twine size and mesh size was also worked out.

126. NAIDU (R M), KHAN (A A) and NARAYANAPPA (G)

Comparative efficiency of frame nets and trammel nets. *Fish. Technol.*, 13 (1), 1976 : 59–61.

Fishing experiments were conducted with frame nets and trammel nets simultaneously in the Hirakud Reservoir. Under identical conditions frame nets gave better catches than trammel nets. *Catla catla* and *Silondia silondia* were dominant species caught and the rest were uneconomical species.

127. GEORGE (N A), KHAN (A A) PANDEY (O P) and MATHAI (T Joseph)

Productivity and seasonal abundance of commercially important fishes of Gobindsagar reservoir. *Fish. Technol.*, 14 (1), 1977: 7–12.

The results of the fishing investigation conducted with gill nets of varying mesh sizes at different centres are presented. The relative abundance of commercially significant species of fishes have been assessed in relation to the three main fishing zones of the reservoir. The seasonal abundance of the different species of fish has also been dealth with.

Labeo displostoma, *Labeo bata*, *Barbus tor* and *Mystes Seenghala* are the main fish species of the reservior. The catch of the above species was observed to be the highest towards the lunkhar arm of the reservoir.

128. NARAYANAPPA (G), KHAN (A A) and NAIDU (R M)

Colloured gill nets for reservoir fishing. *Fish. Technol.*, 14 (1), 1977 : 44–48.

In view of the conflicting and dissimilar results elesewhere and realising the

fact that no two water bodies will be indentical in their physical and fishery conditions, experiments were undertaken to evaluate the utility of coloured nets for fishing in Hirakud reservoir.

Experimental fishing with different coloured nets have shown that white net yielded better catch. The efficiency of the coloured nets was in the order yellow, grey, green and blue. Though there is little evidence to show some species preference to a particular colour the results were not conclusive as the analysis of variance indicated that interaction between species and colour is significant only at 5% level.

129. PANICKER (P A), SIVAN (T M) MHALATHKAR (H N) and MATHAI (P George)

Selectivity of gill nets for *Hilsa toli* and *Pampus argenteus*. *Fish. Technol.*, 15 (1) 1978: 61-68.

Gill nets of 210/2/3 with 51 mm bar mesh and 0.60 hanging coefficient for *Hilsa toli* and 210/2/3 with 63 mm bar and 0.60 hanging coefficient for *Pampus argenteus* are recommeded for the commercial exploitation of these two species of fishes along the Sourashtra coast.

130. GEORGE (V C), KHAN (A A) and VARGHESE (M D)

Rational exploitation of *catla catla* [Ham] from Hirakud reservoir : A preliminary account. *Fish Technol.*, 16 (2), 1979 : 87-90.

Frame nets and simple nets of identical mesh size were experimented to determine their comparative efficiency for exploiting economic size group of catla from Hirakud reservoir. The results indicated frame nets of 90 mm mesh bar as the most effective.

131. KHAN (A A) GEROGE (N A) and PANDEY (O P)

Column set gill net fishing in Gobindsagar reservoir, *Fish. Technol.*, 17 (1), 1980:65.

Kapron gill nets of identical designs were operated side by side as surface and column set under identical fishing conditions. Temperature of water of the fishing ground varied from 13 to 25°C during winter (November to January) and 20 to 33°C during summer (April to June). No difference in catch fo nets set at surface and column during winter could be observed while it was 1.42 times more in suface set nets during summer. The catch consisted of the four main species of fishes viz. *L. diplostoma*, *L. bata*, *B. tor* and *M. seenghala*.

132. KHAN (A A), GEORGE (V C) and VARGHESE (M D)

Eradication of uneconomical fishes with simple gill nets ot Hirakud reservoir. *Fish Technol.*, 17 (1) 1980 : 15-19.

Experiments with simple gill nets of mesh bar 25, 30, 35, 40 and 45 mm were carried out to determine the suitable mesh size for the eradication of the uneconomical fishes of Hirakud reservoir. Results show that net with 25 mm bar is more suitable particularly for the capture of *Gudusia chapra* (Ham), *Rohtee cotio* (Day). and *Eutropichthys vacha* (Ham).

TRAWLS

133. DESHPANDE (S D)

On the fishing experiments conducted with a 10'. beam trawl net. *Indian J. Fish.*, 7 (1), 1960: 174-186.

Details of the first series of experiments conducted with a 10' beam trawl net from a small motorized craft are presented. Catch efficiency of the gear as compared to local seine nets was 3. The operation of gear is simple that the fishermen can easily be trained in a short time.

134. CHOUDHURY (R L Roy)

Design studies of modern trawlers for India. *J. Naval Architecture and Marine Engg. Soc.*, 1960.

The design aspects of boats used for trawling with particular reference to India are presented in this communication.

135. DESHPANDE (S D) and SIVAN (T M)

On the effect of tickler chain on the catch of a 10' beam trawl net. *Indian J. Fish.*, 9 (2) B, 1962 : 91-96

A tickler chain was attached to the ground rope of a beam trawl and performance of the gear was studied in comparison with a net without chain. It was found that the catch/hour/haul of prawns were more (47%) when the tickler chain was attached

136. KURIYAN (G K), DESHPANDE (S D) and GEORGE (N A)

Certain aspects about improved gear in prawn fishing. *Indian Fish. Bull.*, 9 (4), 1962 : 31-36.

This communication is a review of the work so far done with improved prawn fishing gear. From the results of the experiments, it could be concluded that adoption of otter trawl net design with less floats along the head rope, heavier foot rope, comparatively long wings and attachment of a thin tickler chain ahead of the foot rope resulted in a substantial increase in the prawn landings.

137. MIYAMOTO (H), DESHPANDE (S D) and GEORGE (N A)

Recent development in trawl fishing for shrimps from machanished boats on the west cost of Peninsular India. *Proc. Indo – pacif. Fish. Coun.*, 10(2), 1962: 264-279.

This article is a review of the development of trawling for shrimp on the west coast of India. It gives an account of the experimental fishing operations made with various types of trawls, boats and engines of different horse power.

The experimental operations showed that when more floats are attached to the net fish catch was more than the prawn catch. Hence for selective fishing the number of floats to be attached on head rope are to be adjusted. Effect of tickler chain improved the catch of prawns and fish. Tests on the otter trawl showed that using long sweeps is advantageous.

138. SATYANARAYANA (A V V), KURIYAN (G K) and NAIR (R S)

Commercial prawn trawling gear of Cochin (India). *Proc. Indo-Pacif. Fish. Coun.*, 10 (2) 1962: 226-263.

The designs of trawls used commercially for prawn fishing are described along with the details of the boats and specification of the gear.

139. SATYANARAYANA (A V V) and NAIR (R S)

Preliminary studies on the characteristics of otter trawls: Horizontal opening and towing resistance. *Indian J. Fish.*, 9 (2) B, 1962: 133–144.

The paper embodies the results of four series of experiments conducted with different combination of nets and otter doors to study the chief characteristics which contribute to the efficiency of otter trawl gear. The horizontal spread between otter boards was found to increase with speed and length of warp used up to a certain level. The resistance of the gear is compared to bottom friction and resistance of water against net and doors.

140. SATYANARAYANA (A V V) and NAIR (R S)

Designs of otter trawls for shrimps. *Indian J. Fish. Bull.*, 9 (4) 1962 : 4–23.

Systematic studies on the designs of otter trawls have been attempted by the author with a view to work out suitable designs of the gear for small and medium sized mechanised boats. Some of the designs of trawl and otter boards suitable for boats of different sizes are presented.

141. SATYANARAYANA (A V V) and MUKUNDAN (M)

Studies on the otter boards : Angle of attachment of the bridles. *Indian J. Fish*, 10 (2) 1963 : 11–14.

With a view to assess the optimum height of the bridles of the otter boards and their angle of attachment, the authors conducted certain experiments with flat boards fitted with fore brackets having four different perpendicular heights. Maximum horizontal spread was obtained when the angle of attachment of the bridle wos between 35° and 45° for different scope ratios.

142. DESHPANDE (S D), GEORGE (V C) and SIVAN (T M)

Experiments in fishing with shrimp trawls: On the effectiveness of beam trawl net. *Proc. Indo-Pacif. Fish. Coun.*, 11 (2) 1964: 191–197.

1.52 m and 3.04 m beam trawl nets were operated simultaneously from a motorized boat and the results are communicated. It has been observed that about 21% of prawns and 11% of fishes escaped from the larger beam trawl net during the course of operation.

143. DESHPANDE (S D) and KARTHA (K N)

On the results of preliminary experiments with otter trawls off Veraval. *Proc. Indo-Pacif. Fish. Coun.*, 11 (2) 1964 : 184–190.

The results of fishing operations with different shrimp trawls along the coast off Veraval are presented. The gear which proved effective under experimental conditions was tested for increasing the shrimp catches and reducing the miscellaneous varieties of fishes. Based on the results selective fishing for shrimps has been recommended.

144. KURIYAN (G K), SATYANARAYANA (A V V) and NAIR (R S)

Designs of trawling gear. *Proc. Indio-Pacif. Fish. Coun.*, 11 (2), 1964, 204-216.

The paper deals with the development of new designs of trawls for shrimps for operation from small mechanised boats upto 55 ft. in length along the south-west coast of India.

The designs and constructional details of nets, ranging from 47' to 85' and suitable otter boards are detailed.

145. NAIR (R S) and GEORGE (N A)

Four seam trawl nets operated off Cochin : An analysis of the design aspects, the integration of the various parts of trawl. *Fish. Technol.*, 1 (1), 1964 : 1-8.

An empirical formula is derived from the relation between the different parameters of the four seam trawl net. The length of head rope in relation to horse power of engine and relation between buoyancy and sinkers are given.

146. SATYANARAYANA (A V V) and NAIR (R S)

Towing resistance of otter trawls used for shrimps from small mechanised boats. Fish. Technol., 1(2), 1964 : 183-188.

Attempts made to determine the towing resistance of the shrimp otter trawls operated from small trawlers off Cochin are detailed. The actual resistance on the warps under normal fishing conditions has been measured. Engine horse power utilised for towing the gear at normal speed and fishing has also been estimated.

The horizontal spread between the otter doors was more or lass between 50 to 60% of the total length of the head rope including sweeps. The relationship between the BHP of engine and the actual H. P. utilised follow a linear pattern suggesting that these factors are directly proportional.

147. SEBASTIAN (A V), SADANANDAN (K A) and SATYANARAYANA (A V V)

On the prawn trawling experiments conducted off Kakinada (Andhra Pradesh). *Proc. Indo-Pacif. Fish. Coun.*, 11 (2) 1964: 198-203.

The results of trial fishing operation for prawns with both beam and otter trawls off Kakinada are presented. The results corroborated with the findings of experiments done at Cochin in 1959. The catches of beam trawl comprised mainly of small prawns of average length between 8 to 10 cm, where as the otter trawl catch composed of both big and small sized prawns.

148. APPUKUTTA PANICKER (P) and SIVAN (T M)

On the selective action of the cod end meshes of a shrimp trawl. *Fish. Technol.*, 2 (2), 1965 : 220-248.

Selectivity studies using cod end covers to determine the optimum cod end mesh size for commercial size groups of shrimp was carried out at Cochin. From the findings the authors have stressed the necessity of increasing the cod end

mesh size from the then existing size of 25.4 – 31.70 mm to 41.65 mm to avoid depletion.

Use of larger mesh would not only obviate much of the undersized prawns but allow a better flow of water through the net which in turn enable to increase ths efficiency of the net. Further, by increasing the mesh size of the cod end a proportionate increase in the mesh size at the different parts of the trawl could be made.

149. DESHPANDE (S D) and GEORGE (N A)

On the effect of tickler chaln on the catches landed by a 55 ft. trawl net. *Fish. Technol.*, 2 (1), 1965 : 82–86.

The communication deals with the results of comparative tests conducted from Cochin to study the effect of a tickler chain on the catches landed by a 55' shrimp otter trawl. The net was operated with and without chain and 82 hauls of 61 hours and 28 minutes total duration were made. The increase in the catch of shrimp and fish by the net with tickler chain was probably due to the disturbance caused by moving chain attached to the foot-rope on the seafloor

150. SATYANARAYANA (A V V)

Note on the size groups of prawns landed by shrimp trawls of four different cod end meshes. *Fish. Technol.*, 2 (1), 1965 : 87–92.

A study on the different size groups of prawns landed by shrimp trawl nets having different cod-end meshes has been made. The small sized prawns of mesh length 77.15mm were caught by the net having 23.38 mm cod end at 5-6 fathoms depth, medium prawns of mean length 105.22 mm were caught in 25.21 mm and 19.88 mm cod end at 8 fathoms depth and big sized prawns of mean length 117.98 mm were caught in 21.29 mm cod end at 10–12 fatohm depth.

151. MHALATHKAR (H N) and KRISHNA IYER (H)

Belly depth studies for shrimp trawls. *Indo-Pacif. Fish. Coun. Occ. Pap.* 67/6, 1966.

An investigation was undertaken by the authors on shrimp trawls to find out the optimum depth of belly and its effect on the catch.

Investigations were carried out to reduce the belly depth by operating 13.62 m (45 ft) four seam cotton trawl net where the depth of the belly was cut short to approximately one third its original depth in three stages.

152 NAIR (R S), VARGHESE (C P), RAMACHANDRAN NAIR (C) and KRISHNA IYER (H)

On the operation of small shrimp trawls in shallow waters-scope-ratio and size-depth relation. *Fish. Technol.*, 3 (1), 1966 : 59–71.

An attempt has been made to assess the effective scope ratio of warp required for the operation of trawls at shallower depth and to judge the size of trawl suitable for use at shallower depths.

The authors are of the view that a trawl net of size between 35' to 45'. would be suitable for operation in this region, taking into consideration the size, shape and angle of attack of the otter boards for effecting the maximum spread.

153. DESHPANDE (S D) and KARTHA (K N)

Experiments in fishing with shrimp trawls : On the standardisation of tickler chain *Fish. Technol.* 4 (2) 1967 : 62-64.

The experiments conducted off Gujarat coast on the standardisation of 'tickler chain' for shrimp trawls gave the following results:

Of the short link chains made of 3 2 mm, 4.8 mm and 6.2 mm rods the second one showed an increase in the yield of shrimp without affecting the performance of the gear. The different chains used had no influence on the fish catch.

154. MUKUNDAN (M), SATYANARAYANA (A V V) and KRISHNA IYER (H).

On the relative efficiency of different shaped otter boards. *Fish. Technol.*, 4 (2), 1967: 53-61.

The relative efficiency of three different types of otter boards under actual fishing conditions was studied by the authors and the results obtained are embodied in this paper.

Rectangular, horizontal curved and oval otter boards were tested under identical fishing conditions and their relative efficiency ascertained on the basis of towing tension and the horizontal opening of the boards. The tension in the warps with the different otter boards was not significant, the horizontal curved board gave increased lateral spread to the net.

155. DESHPANDE (S D), RAMARAO (S V S) and KARTHA (K N)

Certain observations on the effectiveness of rectangular and oval otter boards. *Proc. Indo-Pacif. Fish. Coun.*, 13(3), 1968: 431-436.

Rectangular and oval otter boards were tested under identical conditions and their relative efficiency was ascertained on the basis of catch landed. A significant increase in the catch was observed with rectangular otter boards.

156. DESHPANDE (S D), SIVAN (T M), KARTHA (K N) and RAMARAO (S V S)

Comparative catch efficiency studies between two seam and four-seam otter trawls. *Proc. Indo-Pacif. Fish. Coun.* 13 (3), 1968: 444-449.

The paper presents a comparative study conducted with two seam and four seam trawls having similar dimension under identical conditions. It was noted that the catch per hour of prawns and fish was higher in the case of the four seam net.

157. NARAYANAPPA (G)

On the relative catch efficiency of different shaped otter boards in bottom trawling. *Fish. Technol,.* 5 (1), 1968 : 15-20.

In order to evaluate the relative efficiency of the different shaped otter boards under identical fishing conditions in terms of catch comparative experiments were undertaken with three different shaped otter boards at Kakinada centre and the findings are reported in this paper.

Three different types of otter boards varying in shape were tried to find out their relative catch efficiency. They were operated with two types of net. The results indicated that the curved otter boards gave more catch per unit effort with all the combinations of nets and riggings tried.

158. NARAYANAPPA (G)

On the optimum length of single sweep wire for an otter trawl. *Proc. Indo-Pacif. Fish. Coun.*, 13 (3), 1968: 437-443.

The paper describes the results of comparative fishing operations done to determine optimum length of a single sweep wire for an otter trawl net. The sweep wires used were of 15 m, 20m, and 25m length. The three sweep wires were operated in rotation with the 19.9m (42.5') two-seam cotton trawl in combination with horizontal curved otter boards. 20m was found to be the optimum length for sweep wire.

159. NARAYANAPPA (G), NARASIMHA RAJU (D A) and SATYANARAYANA (A V V)

Certain observation on the otter trawl operations carried out in the inshore and deep waters off Kakinada. *Proc. Indo-Pacif. Fish. Coun.*, 13 (3) 1968: 450-455.

Preliminary observations on the potentialities of two depth ranges viz. 15-50m and 51-100 m were made to study the catch composition and catch rate. A marked difference in catch composition was also noticed in the two depth ranges and 51-100 m zone landed more catch.

160. VARGHESE (C P), VIJAYAN (V) and KURIYAN (G K)

On the comparative efficiency of conventional and bulged belly fish trawls. Fish. *Technol.*, 5 (1) 1968: 9-14.

A trawl net with a bulged belly was designed and fabricated and the catch was compared with a conventional design under actual fishing conditions. The new design landed 31.8% more fish, there is also saving of material in the new net.

161. NAIR (R S)

General principles of the design of trawl net. *Fish. Technol.*, 6(1), 1969 : 1-8.

The classification and the principles of design of trawl gear together with constructional details are presented.

162. DESHPANDE (S D), RAMARAO (S V S) and VIJAYAN (V)

Results of preliminary fishing trails with 15.8 m six-seam otter trawl. *Fish. Technol.*, 7 (2), 1970: 186-189.

The paper deals with the results of trawling operation conducted along the Saurashtra coast of Gujarat State with 15.8 m, six-seam otter trawl. Fishing operations carried out with this new net were the first of their kind in the country and the results proved to be encouraging.

The design details along with the varieties and quantities of fish landed have been described.

163. DESHPANDE (S D), SIVAN (T M) and RAMARAO (S V S)

Results of comparative fishing trials with rectangular flat and rectangular curved otter boards. *Fish. Technol.*, 7 (1), 1970: 38-41.

The effectiveness of rectangular flat and horizontally curved otter boards was studied by conducting comparative fishing operations off Veraval. Rectangular flat and rectangular curved otter boards were tested under identical conditions and their relative efficiency was ascertained on the basis of catch landed in combination with 13.7m four-seam shrimp otter trawl. Significant increase was observed in the catch when the gear was rigged with curved otter boards.

164. MHALATHKAR (H N) and JAGADEESAN (G)

Belly depth studies for shrimp trawl. Part II *Fish. Technol.*, 7 (2), 1970: 177 - 179.

The paper details with experiments conducted on belly depth studies using four seam shrimp trawl net.

Reduction of the belly depth beyond a certain limit is detrimental to the catching efficiency as well as the mechanical characteristics of the net. The optimum depth of belly was found to be 70 meshes for this particular type of trawl design.

165. MUKUNDAN (M)

Design and construction of flat rectangular otter boards for bottom trawling: A review *Fish. Technol.*, 7(1), 1970 : 1-19.

This review incorporates a historical resume tracing the origin and development of otter boards. The size of the otter board, its relationship with the horse power of the engine, size of the net and the methods of rigging are discussed in detail The effect of the angle of attack, heel, tilt and the ground reaction on the force co-efficients have been studied with particular reference to flat rectangular otter boards used for bottom trawling.

166. SATYANARAYANA (A V V), NARAYANAPPA (G) and NARASIMHA RAJU (D A)

On the relative utility of different methods to increase the vertical height in an otter trawl. *Fish. Technol.*, 7(1) 1970: 23-32.

In order to study the relative utility of different methods for increased vertical spread of bottom trawl, comparative fishing experiments were made using gusse's, kites, separate float line and side panels on a two seam net. The catch rates and composition of fish were studied. Better catch rate with good quatity fishes was obtained with gear operated with separate float line.

167. SIVAN (T M), DESHPANDE (S D), and RAMARAO (S V S)

Some observations on the performance of 10.5m, mid water trawl operated off Veraval. *Fish. Technol.*, 7(2), 1970: 207 - 210.

The results of fishing trials conducted off Veraval with a 10.5m four seam unequal panel mid water trawl with vertically curved otter boards are presented. The horizontal spread of the net, towing resistance offered in action and particulars of fish caught are incorporated. Sciaenids constituted about

38% of the total catch followed by Indian Salmon (21.7%) and lactarius (16.3%).

163. SREEKRISHNA (Y)

Comparative fishing experiments with two trawl designs used in the inshore waters off Kakinada (Andhra. Pradesh). Fish. *Technol.*, 7(1), 1970: 42–47.

Observations made on the relative catch efficiency of two different types of trawl nets used in combination with two different shaped otter boards are incorporated in this communication.

When nets of 11.89 m and 12.96 m were experimented with two combinations of otter boards no significant difference was found between the two.

169. SREEKRISHNA (Y) and NARAYANAPPA (G)

On the trend of prawn catches in bottom trawls in inshore waters off Kakinada (Andhra Pradesh). *Fish. Technol.*, 7 (1), 1970: 33–37.

An attempt has been made to review the availability of prawns round the year and the areas where they occur abundantly.

From the results of fishing operations during the 3 years the extent of availability of prawns for bottom trawls was found. Prawns formed 22.5% of the total catch with an average catch rate of 12.3 Kg/trawling hour. The prawns were found to be abundant during November to February and again from April to July. The depth range of 11-15m yielded better catch rate.

170 MHALATHKAR (H N) and JAGADEESAN (G)

Belly depth studies for shrimp trawls Part III. *Fish. Technol.*, 8(2), 1971: 167–170.

Certain experiments were conducted with 17. 07 m (56') four seam trawl to determine the possibility of reducing the depth of belly for shrimp fishing and also to evolve a possible mathematical equation to determine the maximum depth of belly in shrimp trawls.

The results obtained have not only given corroborating evidence in support of the earlier findings but also helped in arriving at a relationship that for a given stretched width of belly 'L' the stretched depth of belly could be either 2L/5 or 40% of 'L' with an allowance of 2 meshes.

171. NAIR (R S), VARGHESE (C P), GOPALAN NAYAR (S), SYED ABBAS (M) and KURIYAN (G K)

Studies on the length of overhang for trawls. *Fish. Technol.*, 8 (1), 1971: 19–22.

The study is an attempt to evaluate the effect of the overhang as well as to find out its optimum size in a 'bulged belly' type of net.

The investigations have indicated that the overhang significantly affects the output of the nets and the optimum size of square derived at is 1.9 m. In addition, it is also established that the size of the overhang has a bearing on the yield of the nets.

172. GOPALAN NAYAR (S) and NAIR (R S)

Recent trends in the design aspects of four seam otter trawls

operated along the south-west and south-east coasts of India. *Proc. Seminar on Mariculture and Mechanised Fishing*, Madras, 1972: 163–165.

The study relates to certain aspects of the design of four seam trawls operated from selected centres, from Tuticorin in the east coast to Mangalore in the west coast. The size of the vessels used for trawling ranged from 30' 30HP wooden boat to 93' 600 HP steel trawlers and the size of the nets ranged from 15 m to 55m. A comparison of the relationships established in this experiment and the previous shows certain interesting facts. The variations observed in trawls in commercial use are indicative of the fact that fishing enterprises and individuals are slowly switching over to altered designs so that the nets will be able to simultaneously catch fish and prawn.. The analysis also indicate that the designs are aimed at obtaining optimum vertical opening of the net.

173. SATYANARAYANA (A V V)

Certain observations on the future of trawling on the east coast of India. *Proc. Seminar on Mariculture and Mechonised Fishing*, Madras, 1972: 107-111.

A review of the gear research work undertaken along the east coast with Kakinada as base is presented. The observations on the future of trawling mainly depends on the present trend and potentialities of fish production, the knowledge and extent of fishing grounds, existing port facilities and development of new ports for the safe operation of the trawlers, marine weather and current system on the grounds, boat and gear developments and on the infrastructure marketing facilities, servicing facilities for boats and nets and processing facilities, for increased fish production etc., the details of which are enumerated in this paper.

174 SATYANARAYANA (A V V) and NARAYANAPPA (G)

Review of experimental trawling from small and medium sized mechanized vessels off Kakinada *Fish. Technol.*, 9(2), 1972: 97–103.

Due to peculiar ecological and physical conditions prevalent on the east coast, work on developing bottom trawling gear, for small and medium sized mechanized boats off Kakinada has been taken up.

The most suitable otter trawl for small boats was found to be 10.9 to 15 m. two seam trawl with 100 cm X 50 cm X 34 Kg. horizontally curved otter boards together with long single sweep line. For operation from medium sized trawls 18.26 m two seam, 18.3 m four seam and 29.26 m long wing trawls were found suitable. 18.3 m four seam trawl caught considerable quantity of off bottom fishes.

Shrimps predominated in the catches of 29.26m long using trawl. Productive grounds for *Synagris sp.*, *Psenus sp.* and *Decapterus sp.* within 50 to 100m. depth ranges were located for profitable exploitation.

175. SATYANARAYANA (A V V), NARAYANAPPA (G) and NARASIMHA RAJU (D A)

On the comparative fishing experiments with a four seam and a two seam trawls on the east cost. *Fish. Technol.*, 9 (2), 1972: 169–179.

Fishing experiments were undertaken to study the relative utility of four seam type net over a conventional two seam net along the east coast in inshore and deeper zones (upto 100 m).

Four seam net caught 6 to 8% more fish belonging to off bottom region than two seam net. Further, this gear was more selective in obtaining lactarius, which is one of the good varieties of fishes from trawlers. Both nets worked equally well in majority of depth ranges experimented.

176. SREEKRISHNA (Y), SITARAMA RAO (J) DAWSON (Percy), MATHAI (T Joseph) and SULOCHANAN (P)

Mesh selectivity for spotted seer, *Scomberomorus guttatus* (*Bloch & Schneider*). *Fish. Technol.*, 9 (2), 1972: 133-138.

Based on studies conducted at Kakinada in the east coast and Cochin in the west coast, the correct mesh size of the gear used in the capture of commercially important size grop of spotted seer (*S. quttatus*) has been evolved using Baranov's formula.

Taking biological factors into consideration, net in 52 mm bar is suggested for exploiting the fishery from both the coasts of India.

177. KARTHA (K N) and SADANANDAN (K A)

On the design, operation and efficiency of 11 m dual purpose trawl for small mechanised boats. *Fish. Technol.*, 10 (1), 1973 : 79-84.

A design of a dual purpose trawl for operation from small mechanised boats has been worked out and the results of operation of this gear are communicated in the paper. An 11 m. trawl could be successfully operated in mid water and bottom layers of the sea by effecting slight modification in the rigging.

178. NAIR (R S), VARGHESE (C P) and KURIYAN (G K)

Development of trawling in India. Part I *Fish. Technol.*, 10(2), 1973: 97-99.

The development of trawling in India is discussed in this communication. Commercial trawling in India is of recent origin. Beam trawls are probably the simplest among dragged gear. In the wake of large scale commercial exploitation of the prawn resources, the demand for trawling gear of greater capacity increased considerably and paved the way for the introduction of otter trawls. Design of winches and gallows suitable for use by the different classes of vessels are now available readily in India and CIFT has contributed much in their development. Various electronic equipments for measuring the parameters of the trawl gear developed by CIFT are also discussed.

179. NARAYANAPPA (G) and SATYANARAYANA (A V V)

On the optimum buoyancy-weight relation for a bottom trawl. *Fish. Technol*, 10 (2), 1973 : 131-137.

The study was taken up to evaluate the optimum buoyancy-weight relationship for a bottom trawl in order to improve its efficiency and the results are presented.

Comparative fishing operations were carried out with gear using different buoyancy-weight relations. Two nets

viz. 18.26 m two seam nylon and 16.16 m two seam cotton trawls were used for the experiment.

180. SATYANARAYANA (A V V) and NARAYANAPPA (G)

Trawling off Kakinada. *Seafood Export J.*, 5 (3), 1973: 27–30

Results of fishing operations on trawling and gill netting conducted at Kakinada are discussed. It was found that two seam trawls are comparatively better suited for small mechanised boats. Rectangular curved otter board was found to be suitable for the nets. The V. D. type and Hoover types of trawl rigging, the optimum length of simple sweep wire for effective utilisation of trawl gear, the use of additional float line on gusset etc. are studied in detail for increasing the catch efficiency.

Studies conducted also showed that there was no appreciable difference in catch in two seam and four seam nets. The catch/hour of prawn with long wing trawl was 2.2 times more than that of the two seam trawl. 'V' shaped steel otter doors were found to be better in this respect than horizontal curved and vertical curved boards.

181. SUBRAMONIA PILLAI (N), VIJAYAN (V) and GOPALAN NAYAR (S)

Effect of weight of otter boards on the horizontal opening of trawl nets. *Fish. Technol.*, 10 (1), 1973 : 52–54.

The experiments carried out to determine the optimum weight of otter board that should be used along with a trawl gear is described.

The net fitted with otter boards weighing 55 Kg. was giving significantly higher horizontal opening, prawn catch and fish catch compared to net fitted with otter boards weighing 50 and 60 Kg.

182 KARTHA (K N), GEORGE (V C) and RADHALAKSHMI (K)

On the comparative efficiency of trawls made of cotton, polyethylene and combination of both the materials. *Fish. Technol.*, 11 (1), 1974: 43–49.

The merits and demerits of cotton polyethylene and a combination of the two materials as trawl net material ascertained on the basis of comparative fishing experiments are detailed.

183 NARAYANAPPA (G), SREEKRISHNA (Y) and SADANANDAN (K A)

On the resources of demersal fishes for bottom trawling in inshore waters off Kakinada by small machanised boats. *Fish. Technol.*, 11 (2), 1974 : 137–141.

An attempt has been made to assess the resources of demersal fishes off Kakinada

From the experimental fishing operations conducted in the inshore waters it was found that prawns and sciaenids constituted 45% of the total catch. The catch rate increased with increase in the depth of fishing upto 21–25 m beyond which reduced.

184. KARTHA (K N)

Evolution of suitable type of bottom trawls for the medium size steel trawlers of Orissa Fisheries Department. *Fish. Technol.*, 13(2), 1976 : 126–132.

The paper deals with the results of fishing operations conducted with conventional trawls of size 22.3 - 25.6 m and improved gear of 32 m long wing and bulged belly designed and developed at this Institute from four medium size trawlers of Orissa Fisheries Department. By employing suitable and standard size gear there was proper utilisation of the engine power with resultant increase in the total landings of shrimps and off bottom fishes.

185. SATYANARAYANA (A V V) and NARAYANAPPA (G)

Preliminary observations in the design and operation of a three panel, double trawl net. *Fish. Technol.*, 13 (1), 1976 : 54–58.

Fishing operations were conducted off Kakinada using a three panel double trawl net with twin cod ends to study the utility of the net in catching both bottom and off bottom fishes. The observations indicate that the net is effective in simultaneous catching of bottom as well as off bottom fishes and separating them while in operation. The design details of the net and the particulars of the fishing operations conducted are presented.

186 SATYANARAYANA (A V V), NARAYANAPPA (G) and DAWSON (Percy).

Studies on long wing trawl for shrimps off Kakinada (A. P) coast: Results of comparative fishing experiments with the conventional two seam trawl. *Fish. Technol.*, 13 (2), 1976: 101–104.

Comparative fishing operations with two seam net of 13.26 m and a 29.26 m long wing shrimp trawl of four seam type were undertaken. The result showed that the long wing four seam net gave twice prawn catch than that of the conventional type. It was also found that this net can be developed into a combination trawl for the effective exploitation of both prawns and fish along the coast off Kakinada.

187. KARTHA (K N), HRIDAYANATHAN (C) and CECILY (P J)

Comparative efficiency of trawls made of nylon, polyethylene monofilament and tape twines. *Fish. Technol.*, 14 (1), 1977 : 21–26.

Results of comparative fishing operations conducted with three nets of identical design made of nylon, twisted polyethylene monofilament and high density polyethylene (HDPE) tape twines are presented.

Tape net recorded the highest catch followed by monofilament and nylon nets. The experimental fishing has proved the suitability of weaving tape as a trawl net material.

188. RAMARAO (S V S), MATHAI (P George) and PANICKER (P A)

Twin trawling for shrimp with dummy doors. *Fish. Technol.*, 14 (2), 1977 : 153–158

Twin trawling, a new concept in shrimp trawling is described. Two trawls of equal size were connected in sequence at the inner head and foot rope legs. A pair of outer otter boards and central neutral door or dummy door with triple bridles and single tow warp were used for operation. A comparative study with conventional stern trawling using a standard 13.7 m four seam shrimp trawls

and two 6.8 m standard for seam trawls as twin-rig has shown considerable reduction in the utilization of power (20%) with better efficiency in shrimp fishing.

189. PANICKER (P A), SIVAN (T M), KARTHA (K N) and GOPALAN NAYAR (S)

Parallel twin-body trawl for shrimps: Its design and efficiency. *Fish. Technol.*, 15 (2), 1978: 95-99.

An attempt has been made to study the performance of a new 17 m parallel twin-body trawl and a 17m bulged belly trawl off Cochin.

The parallel twin body trawl showed an increase of 28% catch over that of bulged belly. The increase in catch is attributed to the extra wide mouth opening (26.6%) of the parellel twin-body trawl. The gear utilized lesser resistance when compared to bulged belly trawl.

190 SATYANARAYANA (A V V), NARAYANAPPA (G) and CHANDRAPAL (G D)

Further investigations on the relative efficiency of different shaped otter boards. *Fish. Technol.*, 15 (1), 1978: 13-19.

Horizonal curved, vertical curved and V-shaped otter boards were studied to compare their relative efficiency under identical fishing conditions.

The gear operated with V-shaped otter boards performed well followed by the gear fitted with horizontal curved boards. Vertical curved boards were found to be comparatively less efficient, but with slight modifications they could be used advantageously for bottom and off bottom fishes.

191 SUBRAMONIA PILLAI (N), VIJAYAN (V), HRIDAYANATHAN (C) and MANOHARADOSS (R S)

Evolution of suitable trawl nets for medium size trawlers: I-Comparative fishing efficiency between 32m bulged belly, long wing and four panel trawls. *Fish. Technol.*, 15(1), 1978. 71-75.

Comparative studies on the efficiency of 32 m bulged belly, long wing and four panel trawls have shown bulged belly trawl to be superior to the other nets in catching bottom fishes and column fishes. 40% of the bottom fishes and 48% of the column fishes were caught by the bulged belly trawl. However, the long wing trawl landed 52% of the total prawn catch among the three nets.

192. KUNJIPALU (K K), KUTTAPPAN (A C), and MATHAI (P George)

New large mesh trawl for demersal fishery. *Fish. Technol.*, 16(1), 1979: 19-27.

Investigations with new 32 m large mesh demersal trawl were carried out off Veraval and the results are reported. The large mesh demersal trawl of 32 m head rope length was found to be efficient for the exploitation of demersal fishes off Veraval. This net was compared to a standard bottom trawl of 32 m head rope length with small meshes. The increase in the mouth area of large mesh trawl enhanced the fishing power by covering more area per tow. The net is simple in constructoin and easy to repair.

193 KUNJIPALU (K K), MATHAI (P George), and KUTTAPPAN (A C)

Development of trawls for medium sized trawlers for Veraval, North-west coast of India. *Fish. Technol.*, 16 (2), 1979: 55-64.

Comparative fishing experiments with 25 m bulged belly and 25 m six seam trawls were carried out to study the relative efficiency of the gear. Bulged belly trawl was found to be more efficient than the other at depths below 40 m. Bulged belly caught more of prawns and lobsters but there was no significant difference in the catch of sciaenids, cephelopods and ribbon fishes in the two nets.

194. PANICKER (P A), SIVAN (T M), RAMA RAO (S V S) and GEORGE (T P)

Double-rig shrimp trawling: Its rigging, comparative efficiency and economics. *Fish. Technol.*, 14(2), 1979: 141 - 152.

Studies carried out with a 13.7 m four seam shrimp trawls as conventional single-rig and two 6.8 m four seam shrimp trawls as double-rig from a 15.2 m fishing vessel are discussed. An increase of 98% shrimp catch was recorded by double-rig over single rig trawl.

195. SUBRAMONIA PILLAI (N), GEORGE (N A) and KESAVAN NAIR (A K)

Evolution of suitable net for medium sized vessels : II-Introduction of large meshed high opening fish trawl. *Fish. Technol.*, 16 (2), 1979 : 65-70.

Large meshed high opening trawl was found to be very efficient for the exploitation of column and off bottom fishes. The net was found to be efficient in capturing different varieties of column fishes comprising of squids, pomfrets, barracudas, cat fishes, sharks and rays

The net offers 18% lesser resistance than bulged belly net which in turn resulted in utilization of lesser horse power. This trawl is very simple in construction and requires minium maintenance because of reduced number of meshes The total cost of the net is less by 35% as the larger mesh size reduces the material requirement and cost of fabrication.

196. KARTHA (K N)

Prospects of introducing midwater and pelagic trawling along the Indian coast from 9.75 m to 15.4 m (32' to 50') boats. *Fisherman*, 1 (2), 1980: 27-29.

A review of the work done in India in estimation and expolitation of pelagic resources and scope of introducing mid-water and pelagic trawls from 9.75 m 15.4 m are highlighted. Due to diminishing returns of shrimp trawlers this can be adopted as an alternative method for economic running of fishing boats along the Indian coast for exploitation of column and pelagic fishes.

SEINES

197. DESHPANDE (S D) and GEORGE (V C)

Design and operation of 'Kollachi vala' : A two boat seine for Gar fishes *Proc. Indo-Pacif. Fish. Coun.*, 10 (2) 1962 : 286.

The paper gives in detail the materials, design, method of construction, preservation and *modus operandi* of the 'Kollachi vala' an indigenous two-boat seine operated along the Kerala coast for capture of Gar fishes.

The design of the nets is more or less similar to an inverted trawl with short wings. The materials used for construction are hand twisted cotton twines. Dragging the net towards the fish and against its swimming direction is the main principle behind the operation of this net. Due to the peculiar leaping habit of fish when scared, catch depend entirely on quickness of operation on the part of the fishermen while encircling the shoal and hauling the net.

198. KURIYAN (G K), GEORGE (V C) and MENON (T R)

Design and operation of the so-called 'Thanguvala' : A single boat seine. *Indo-Pacif. Fish. Coun. Occ. pap.* 63/2 1962 : 1-10.

The materials, design, method of construction and operation of "Thanguvala", a Single-boat seine of the Kerala coast, are presented.

The net is a semi-circular bag without wings, having an upper and lower half with an opening at the straight line edge. The floats, sinkers and the side lines are rigged to the corresponding mounting line at intervals or 10 to 12" by the rigging twines. The net dyed in tannin extract and treated at regular intervals lasts for 2-3 years

The crafts used for the operation of the net are canoes, either dug-out or plank built.

199. SADANANDAN (K A), KUNJIPALU (K K), GEORGE (N A) and MATHAI (T Joseph)

Purse seines off Goa. *Fish. Technol.*, 12 (1), 1975 : 45-51.

This communication presents the design, construction and operational details of the purse seines operated from Goa for sardines and mackerel. The deck equipments and details of vessel along with the fishing seasons, fishing grounds and catches are briefly accounted. The design has been compared with Japanese purse seines operated for the same species of fishes. Based on the findings an improved design of purse seine has been presented.

200. PANICKER (P A), GEORGE (N A) SIVAN (T M)

Prospects of exploitation of pelagic fishery resources by purse seining from small class of vessels. *Fisherman*, 1 (2), 1980 : 42-48.

Hitherto mechanisation was on the exploitation of shrimp and demersal fishery resources. Owing to large influx of mechanised vessels fishing has become uneconomical. The exploitation of our rich untapped pelagic fishery resources of about 0.3 million tonnes of sardine and mackerel by purse seining and mid water and pelagic trawling by the existing fishing fleet will go a long way in improving the economy of the industry. The outlay on fishing crafts and estimated earnings are detailed.

BIOLOGY

201. MIYAMOTO (H) and SHARIFF (A T)

Lobster fishery off the South-West coast of India: Anchor hook and trap fisheries. *Indian J. Fish.*, 8 (1), 1961: 252

Four kinds of fishing gears in use along the south-west coast of India, traps, anchor hooks, scoop nets and bottom gill nets are described. It was found that *Panulirus burgesi* is the most common species caught in large quantities. Specimens of *P. penicillatus* and *P. polyphagus* were also obtained off Quilon and Vizhingam.

202. SATYANARAYANA (A V V)

Record of *Panulirus penicillatus* (Oliver) from the inshore waters of Quilon (Kerala). *J. Mar. Biol. Ass. India*, 3, 1961: 1–2

During the lobster gear investigations conducted with specially designed bottom-set gill nets along the south-west coast of India, in one net operated off Tangassery (Quilon), a single large sized lobster, which is distinctly different from all others obtained at this place as well as from other fishing centres namely Varkala, Vizhingam and Colachel-Muttam, was caught. On identification, it has been found to be *Parulinus penicillatus* (Oliver).

203 BALASUBRAMANYAN (R)

On the occurrence of Palinurid spiny lobster in the Cochin backwaters. *J. Mar. Biol. Ass. India.* 9 (2), 1967 : 435-438.

During the lobster fishing experiments conducted by the author along the south-west of India, a specimen of *P. polyphagus* measuring 36 mm in length and weighing 1.36 kg was caught from a sandy bottom at a depth of 10m., while the rest of the catches were taken exclusively from rocky substratum. The present observation suggests that *P. polyphagus* unlike the other rock dwelling lobsters (*P. ornatus; P. dasypus; P. versicolori; P. Penicillatus* and *P. japonicus*) does not exclusively confine themselves to rocky beds but disperses to other adjoining shallow sandy and muddy areas.

204. BALASUBRAMANYAN (R)

Spiny lobsters of India and the present status of their fishery. *Indian Seafood*, 4 (3), 1967 : 3-5.

At present very little is known on the complete biological history of the different species of lobsters recorded in Indian waters. A detailed survey during the four consecutive fishing seasons along the west and east coasts of India with special reference to lobster fishing gears was conducted by the author.

205. GEORGE (V C), GOPALAN NAYAR (S) and KRISHNA IYER (H)

Mesh regulation in backwater prawn fishing gear *Fish Technol.*, 11 (2), 1974 : 117–128.

The size grade composition of prawns of different species caught by backwater prawn fishing gear of Kerala is described along with their relative economics.

It has been shown that enhancement of mesh size has no adverse effect on fishing economics. The mesh size recommended for stake nets range from 20–25 mm.

206. KHAN (Anwar Ahmed), NAIDU (R M) and NARAYANAPPA (G)

Note on an abnormal catch of *Catla catla* in Hirakud reservoir. *Fish. Technol.*, 11 (1), 1974: 73–74

During the experimental fishing operations in the Hirakud reservoir, an abnormal catch of *Catla catla* (405 Kgs.) was caught in a single day's operation. The details of fishing operation and the gear operated are enumerated by the authors.

207. KUNJIPALU (K K) and MATHAI (P George)

Catch of a whale shark, *Rhincodon typus* (SMITH) off North West coast of India (Veraval). *Fish. Technol.*, 13 (2), 1976 : 161–162.

11m. trawler of Central Institute of Fisheries Technology during its regular fishing experiments off Gujarat coast caught a giant shark measuring 6·65m. in total length and 1.5 tonnes in weight. The specimen has been identified as Rhincodon *typus* commonly known as whale shark or basking shark. There is no record of whale shark caught by a trawl net along the Indian coast.

208. MATHAI (T Joseph) and KESAVAN NAIR (A K)

On certain allometric relations of the spiny lobster *Panulirus polyphagus* (Herlist). *Fish. Technol.*, 16 (2), 1979: 83–85.

Certain allometric relations of the spiny lobster *Panulirus Polyphagus* are derived. While the relation between tail length and tail weight is made for both the sexes together, separate relations are derived for the sexes in the case of tail length versus total length. For conservation and economic purposes, it appears that the under sized ones are to be released alive.

PACKAGING AND TRANSPORTATION

209. RAO (C V N) and PERIGREEN (P A)

Studies on packaging of fresh fish. *Fish. Technol.*, 1 (1), 1964: 68–75.

Studies conducted in the laboratory and field have shown that iced fish can be preserved for longer periods in fresh and edible condition in conventional bamboo baskets by providing insulation linings of gunny and polythene or bitumen coated kraft paper. Temperature distributions in fish stored in bamboo baskets provided with different linings (fish : ice :: 1:1) for different periods were noted and the maximum periods for which the fish could be preserved in different packings before attaining temperature ranges e. g. 5°C – 5.8°C and 7.2°C – 9.4°C were worked out. TMA, TVB and organoleptic evaluations were made at suitable intervals during the storage periods.

210. KAMASASTRI (P V), SADANAND (Ghadi) and RAMANANDA RAO (D)

Studies on the storage characteristics of silver pomfret (*Pampus argenteus*) transported to Bombay. *Fish. Technol.*, 4 (2), 1967 : 71–77.

Studies on the quality of pomfrets transported to Bombay from Gujarat coast and subsequent changes during storage at atmospheric and low temperatures were carried out. Physical, chemical organoleptic and bacteriological qualities of the pomfrets transported from Veraval to Bombay by country crafts and mechanised boats in insulated and non-insulated ice holds were examined.

The pomfrets transported in mechanised boats having insulated holds were in better condition than those transported in non-insulated holds. In general, the transported fish can be effectively stored in ice for 2 days, while they remained in acceptable condition upto 4 days.

211. PERIGREEN (P A)

Studies on transportation of fish: I. Packaging of frozen fish in insulated containers. *Fish. Technol.*, 5(1), 1968: 43-48.

The paper deals with certain technological aspects of transportation of fish. Frozen fish packed in thermocole insulated plywood box and transported remained in good condition for 3 to 4 days. Fish reaching the destination in a thawed state, can be stored in crushed ice for a further period of 2-3 days. The effect of initial temperature of frozen fish on the storage life, the maximum storage period for different types of frozen fish packed in the insulated container and the changes in chemical and organoleptic qualities of different varieties of fish under conditions of transport are discussed.

212. PERIGREEN (P A) and GOVINDAN (T K)

Transportation of fish in India : Problems and prospects. *Fish. Technol*, 6 (2), 1969 : 74-78

One of the most important methods of economic utilisation of fish is to transport them expeditiously to internal markets. Some of our potential internal markets are thousands of kilometres away from the fish landing centres. The extensive programme of study conducted at the Institute on problems of transportation and some of the salient points observed are summarised in this communication A thermocole insulated plywood container was developed for transportation of fish-iced and frozen. Field trials were successfully carried out based on the findings.

213. GOVINDAN (T K)

Scientific transportation as a booster to the marine fisheries of Andhra Pradesh. *Souvenir Andhra Fishermen's Central Co operative Society* Ltd., Kakinada, 1974.

With the introduction of more and more mechanised boats and simultaneous provision of the necessary infrastructure, the fish landings of the state can be increased substantially. Methods employed in transportation still remain primitive. There is plenty of scope for deveioping this industry in the State using scientifically prepared insulated containers and insulated or refrigerated trucks for quick road transport. Experiments conducted from Kakinada have shown that iced and frozen fish could be transported in prime condition in thermocole insulated plywood or galvanised iron boxes to distant destinations by rail at ambient temperatures.

214. RAO (C V N)

Packages for marine products. *Proc. Symposium on Fish Processing Industry in India*, Mysore, 1975: 59.

This paper reviews the present status of packaging in fishing industry and outlines the scope for further improvements in some areas for internal and external trades.

215. VENKATARAMAN (R), VARMA (P R G), PRABHU (P V) and VALSAN (A P)

Transportarion of fish : I-A preliminary study on insulated containers and their efficacy in long distance transportation. *Fish. Technol.*, 13 (1), 1975 : 41-48

Polythene lined thermocole insulated plywood boxes could be successfully used for the transport of fresh iced fish. A minimum of 25 mm thermocole insulation was necessary during summer and 15 mm during winter. By using these insulated boxes the initial fish to ice ratio of 1:1 could be brought down to 1 0.75 and still further to 1:0.5 at the height of winter in January and February. The second hand tea chests are robust and able to stand a minimum of 5 trips to and fro.

Moulded polystyrene boxes are found not suitable for long distance transport. In the non-insulated boxes the loss due to spoilage ranged from 10% to 25% and this could be completely eliminated by the use of insulated boxes.

216. PERIGREEN (P A) and NAIR (M R)

Handling and transportation of fish in India *Proc. Workshop on Handling, Processing and Marketing of Tropical fish*. TPI, London, 1976: 177-180.

The pattern of handling and transportaion of fish in India, where 65% of the total fish landings is marketed in fresh condition, remained more or less unchanged until recent years. Unscientific methods are being used even now in some parts of the country. This paper describes briefly various aspects of handling fish on board fishing vessels and at landing centres, conventional type of containers, mode of transport used in the fish trade and recent developments in the field of internal distribution of iced and frozen fish. The present methods of handling and transportation of frozen prawns, the most important fishery product exported from the country are also discussed.

217. GOVINDAN (T K), GUPTA (Sibsankar) and CHATTOPADHYAY (P)

Investigations on long distance transportation of fish. I- Transportation of frozen fish from Cochin to Calcutta. *Fish. Technol.*, 14 (2), 1977 : 108-115.

Oil sardine (*Sardinella longiceps*), mackerel (*Rastrelliger kanagurta*), catfish (*Arius sp.*), threadfin bream (*Nempiterus japonicus*) and ribbon fish (*Trichurus sp.*) were frozen in glazed and unglazed blocks, packed in expanded polystyrene (E P S) insulated plywood boxes with and without additional ice and despatched in uninsulated parcel vans of trains from Cochin to Calcutta. The results are presented in this paper.

Fish in frozen fo m can be transported by rail in ordinary parcel vans from Cochin to Calcutta in 2.5 cm thick EPS insulated plywood boxes without reicing enroute. Even in the absence of glaze and additional ice, the frozen fish withstood the transportation under the conditions of the experiments reported.

218. GOVINDAN (T K), GUPTA (Sibsankar), VARMA (P R G) and CHATTOPADHYAY (P)

Investigations on long distance transportation of fish : III Field trials with a dismantlable Insulated galvanised iron container. *Fish. Technol*, 15 (1). 1978 : 31–35.

The paper communicates the results of field trials conducted with a dismantlable insulated galvanised iron container designed and fabricated for long distance transportation of fish.

Different varieties of fishes packed in different types namely, fresh iced, chilled iced and frozen were employed in the transportation experiments which were conducted from Kakinada to Howrah, Kakinada to New Delhi and Paradeep to Howrah. In all the experiments the container performed exceedingly well and has remained in very trim condition.

219. GOVINDAN (T K) and GUPTA (Sibsankar)

Dismantlable container for long distance transportation of fresh fish. *Res. & Ind.* 23 (2), 1978 : 85–87.

A dismantable container in double layer 22 gauge galvanised iron sheet sandwitching 25 mm thick expanded polystyrene slab as insulation material and having internal dimensions of 457 mm^3 has been designed and fabricated. It consists of six pieces assembled together with bolts and nuts.

220. PANDURANGA RAO (C C), GOVINDAN (T K), GUPTA (Sibsankar), CHATTOPADHYAY (P) and RAJAGOPALAN UNNITHAN (G)

Investigation on long distance transportation of fish: IVA comparative study of the performance of expanded polystyrene slabs and multi-layer gunny (jute) fabric as insulants. *Fish. Technol.*, 15 (2), 1978: 89–93.

An attempt is made to carry out a comparative evaluation of the insulation efficiencies of 25.4 mm thick expanded polystyrene slabs and two and four layer gunny (jute) fabric, all sealed in 150 gauge polythene sheet in experimental tran portation of fresh iced fish from Kakinada to Calcutta employing chemical, physical and organoleptic alterations occurring in the transported fish as criteria for evaluation. All the three insulants tried showed comparable insulation efficiencies considering total bacterial counts, organoleptic qualities, TMA and TVN values of the transported fish as parameters.

221. PANDURANGA RAO (C C), GOVINDAN (T K), GUPTA (Sibsankar), CHATTOPADHYAY (P)

Investigations on long distance transportation of fish: V Transportation of filleted and round seer fish (*Scomberomorus* sp.) from Kakinada to Calcutta by rail. *Fish. Technol.*, 16 (1), 1979: 11–13

The study envisages the comparative amenability of seer (*Scomberomorus* sp) in round and fillet forms to transportation in 2.54 cm thick expanded polystyrene insulated plywood boxes from Kakinada to Calcutta and their consumer appeal in the Calcutta market in terms of their auction sale values.

While both the forms withstood the rigours of transportation squarely the fillets fetched only half the price of round fish in the auction conducted at the Calcutta market.

222. PANDURANGA RAO (C C), GOVINDAN (T K), GUPTHA (S S) and IMAM KHASIM SAHEB (D).

Studies on transportation of *Chanos chanos*. Symposium on Coastal Aquaculture, Cochin; India. 12th - 18th January, 1980.

The paper presents results of studies undertaken with a view to devising suitable methods of transportation of fresh and frozen *Chanos chanos* to distant places by rail. Freshly harvested and frozen fish were transported to Calcutta, Delhi and Madras in different types of containers with different insulation materials. Quality of the fish was examined at both despatching and receiving centres to follow the changes during transportation. Plywood boxes with expanded polystyrene slab and multi-layer gunny insulations, aluminium box with insulation and dismantlable galvanised iron box with insulation were tried for transportation of the iced fish from Kakinada to Calcutta. The journey lasted 40 hours with one transhipment at Samalkot Junction. The fish transported in all the above containers reached the destination in fair to good condition. Frozen *Chanos chanos* in the form of blocks were also transported successfully from Kakinada to Calcutta and Delhi, the later involving a journey of 50 hours and one transhipment at Vijayawada Junction. A few consignments of iced fish sent to Delhi and Madras also reached the destination in good condition. Conventional bamboo baskets with palmirah leaf linings inside and gunny wrapping outside were found suitable for transporting iced fish to Madras by rail.

FISH PROCESSING TECHNOLOGY

HANDLING OF FRESH FISH

223. PILLAI (V K) and LEKSHMY (A)

Use of chilled water in prawn processing work. *Curr. Sci.* 30, 1961 : 388.

The effect of using chilled water (0°C) and tap water [25°C] during the various stages of processing of prawn has been studied. Samples were drawn at different stages and their total bacterial counts were noted. Samples washed in tap water showed considerable increase in the bacterical counts during the interval between washing and packing. Use of chilled water during different stages of processing of prawns helped in keeping down the bacterial load in the frozen products.

224. GOVINDAN (T K)

Studies on ice-stored prawns *Indian. J. Fish.*, 9 (1) B, 1962: 1–15.

Icing of prawns is a very important step for maintaining the quality of the material. The significant changes taking place in the prawn muscle during ice storage were studied in detail. Moisture content, total nitrogen, water soluble nitrogen and

non protein nitrogen of prawn muscle during ice storage were determined at intervals between 2 to 20 days.

Under the influence of the leaching of soluble nitrogenous constituents from the muscle and absorption of water by the muscle from the melted ice, the total nitrogen, water soluble nitrogen and non-protein nitrogen contents of the prawn muscle showed very rapid fall especially during the first 8–10 days of storage.

225. JACOB (Susamma), MAHADEVA IYER (K), RAJENDRANATHAN NAIR (M) and PILLAI (V K)

Quality studies on round, headless and peeled and deveined prawns held in ice storage. *Indian J. Fish.*, 9 (2), B 1962: 97–107.

Knowledge of chemical and bacteriological changes occuring in whole, headless, peeled and deveined prawn is of considerable importance to the industry in order to predict the quality of the processed products.

Studies carried out on commercial samples showed that the values of TVN, TMAN and VAN were more or less similar in the different types of dressings and does not indicate any significant change during 10 days of storage in crushed ice. The rate of fall in the levels of free alpha-amino nitrogen and soluble orthophosphate, was in the order rounds, headless, P&D. Development of blackening in *M. affinis* during ice storage was 100% in 8 days in the case of headless prawns. The test reduction and bacterial count support the view that for short term storage, the prawns held as headless were comparatively of better quality than rounds or P & D. P & D prawns also showed greater rate of loss of solids especially proteins.

226. NAIR (M R), IYER (K M), APPUKUTTAN (P N) and JACOB (S)

Storage characteristics of prawns held in crushed ice and chilled sea water. *proc. Indo Pacif. Fish. Coun.*, 10 (2), 1962 : 294.

The effect of holding prawns in crushed ice and chilled seawater on their storage characteristics has been studied. Samples from each lot were taken at intervals and subjected to chemical analysis. It was found that there was progressive loss in total solids, ash, NaCl, total nitrogen, non-protein nitrogen, alpha-amino nitrogen and orthophosphate of meat during storage in crushed ice. In the case of prawns held in chilled sea water too, the total solids are continuously lost but the loss was off lesser magnitude. Subjective assessment has indicated the superiority of prawns held in chilled sea water to those kept in crushed ice.

227. JACOB (Susamma), KARTHIAYANI (T C) and RAJENDRANATHAN NAIR (M)

Effect of aureomycin on the behaviour of certain free amino acids in oil sardine (*Sardinella longiceps*) held in ice storage. *Fish. Technol.*, 1 (2), 1964: 164–167.

Oil sardines treated with aureomycin solution, packed in polythene bags and stored in crused ice along with untreated ones for a period of 26 days were examined for total counts and amino-nitrogen contents. The bacterial counts showed considerable reduction on treatment with antibiotic. The amino-nitrogen contents increased by nearly three fold during the period of 26 days in ice.

In fish treated with aureomycin at 50 ppm. level, most of the amino acids showed remarkable changes in trend by about the 16 th day of ice storage. Leucine and valine indicated regular increases throughout the storage periods in treated and untreated fish.

228. BOSE (A N)

Increasing fish consumption in India by improved handling. *Proc. Indo-Pacif.. Fish Coun.*, II(3), 1965, 103--111.

The existing facilities available for fresh fish handling transport and role of Government in improving these facilites are discussed.

A review of research work done at CIFT on preservation of fish, their transportation and standards for canned, frozen and dried products have been presented.

229. PILLAI (V K), NAIR (M R) and CHOUDHURY (D R)

Studies on handling, preservation and processing of prawns in India. *Proc. Indo-Pacif. Fish. Coun.*, II (3), 1965 : 112–127.

The paper gives details of the researches carried out in India on handling of fresh prawns prior to further processing such as freezing and canning with a view to ensuring a good quality product. The susceptibility to rapid deterioration of prawn at tropical atmospheric temperature brings in the need for resorting to suitable preservation methods. During prolonged storage in ice, the prawn progressively lose its characteristic flavour primarly due to loss of soluble nitrogenous matter by the leaching action of ice. Prawns packed in ice and covered with water were less prone to blackening (melanosis). For canning ice stored prawns, blanching process has to be carefully controlled so that correct drained weight could be ensured.

230. GOPALAKRISHNA IYER (T S) and CHOUDHURI (D R)

Influence of ice on the bacteriological quality of the processed fishery products. *Fish. Technol.*, 3 (2), 1966: 113–117

The influence of ice on the bacteriological quality of processed fishery products has been discussed. Purity of ice and water is very important to improve the bacterial quality. The sources of contamination of ice and its remedies have been described.

231. GOVINDAN (T K)

Some common defects in prawn processing: Their sources and remedies. *Fish. Technol.*, 3 (1), 1966: 10–15.

The quality of the landed material depends to a great extent on the care with which they are handled and stored in the fishing vessel. Immediate icing after catch is recommended and icing must be done in alternate layers. The prawns must be beheaded as quickly as possible. Unprotected sources of water for cleaning the raw materials result in contamination with heavy bacterial loads. The whole process of preparation of raw material should be done as quickly as possible. The quicker the material is frozen, the more it retains the characteristic properties of the fresh material. Bacterial contamination in cooked frozen prawns occurs during the time interval between cooking and freezing and the sources are the water used for chilling after cooking, which can be overcome by

using specially chlorinated water for chilling, glazing and reglazing.

Some of the defects observed in canned prawns are poor appearance occuring due to prolonged storage of the raw material in ice, insufficient cleaning, low vacum and over-filling, variations in the salt and acid contents in filling brine, blanching conditions and defective grading, cooking and cooling. Factory hygiene and personal hygiene are also to be looked into. In dry prawn industry, if best quality product is desired, the prawns must be peeled, deveined, cooked and then dried or cooked whole, hand peeled and dried. Better methods of production of dry prawns are by use of tunnel dryer and drum dryer.

232. GOPALAKRISHNA IYER (T S) and CHOUDHURI (D R)

Advantage of salt treatment in frog legs processing. *Sci. & Cult.* 34 (7), 1968 : 299-301.

A simple but very efficient method has been worked out for easy handling of live frogs for cutting the legs as well as for preventing bacterial contamination of cut legs.

Experiments using common salt solutions of different concentrations for a pre-dip of the live frogs have shown that at levels of 10% NaCl or above, a 10 minutes dip paralyses the frogs so that cutting of the legs become easy and less painful. This treatment has also been found to remove the contaminating organisms from the skin surface with the result that the finished products are almost completely free from pathogens like *E. Coli*.

233. RAO (C V N)

Some observations on handling fresh prawns. *Indian Fd. Packer*, 22 (4), 1968: 1-5.

Different designs of fish holds having thermocole insulation and their ice consumptions during the fishing voyage were worked out for fishing boats 9.14 m 9 75 m, 10 97 m, 12.2 m, 14.9 and 16.76 m. in 10 cm. layer of iced prawns at different intervals of storage period. The temperature distribution of fish stored in bamboo baskets provided with different insulation linings was also found out.

234. GOVINDAN (T K)

Further studies on ice-stored prawns *Indian Fd. Packer*, 23 (2), 1969: 37-41.

This paper reports the results of studies made on ice stored prawns. Eventhough WSN and NPN contents of prawn muscle show a rapid fall during storage in ice, the TN content remains constant when expressed on dry weight basis, because the dissolution of soluble material by the melting ice does not cause a reduction in weight as would be expected. Instead the muscle takes up moisture to compensate for the lost weight. This study also proves that the TN content of the soluble and insoluble fractions of the prawn muscle are the same, as otherwise the dissolving out of soluble portion should have caused a difference in the TN contents of the insoluble fraction still remaining in ice.

235. GOVINDAN (T K)

Preservation of fish in refrigerated sea water. *Seafood Export J.*, 1 (9), 1969 : 29-32.

The principle involved in this method is to store the fish in natural or artificial seawater cooled to 30°F. It appears to be more suited for storing fish on board fishing vessels. The author has given a diagramatic representation of an RSW fish preservation unit with a detailed discussion on its usage. This method appears worthwhile trying for transportation of fresh fish also because of its more efficient control on the temperature of the fish than the existing methods of refrigeration.

236. CHINNAMMA (P L), CHAUDHURI (D R) and PILLAI (V K)

Technological aspects of processing of edible mussels, clams and crabs: Spoilage during ice storage. *Fish. Technol.*, 7 (2), 1970: 137-142.

The aim of this study was to determine the maximum period for which mussels, clams and crabs under normal icing conditions can be stored prior to freezing. Importance was given to the organoleptic and taste panel studies as none of the objective tests correlated satisfactorily with the subjective taste panel studies. Rate and pattern of spoilage of some of the economically important edible species of shell fishes viz. *Mytilus edulis* (Mussel), *Villorita conurcopia* (clam), *Neptunus pelagicus* (crab) and *Scylla serrata* (crab) have been discussed in this communication.

Chemical indices used for objective evaluation of quality were water extractable nitrogen (WEN), non-protein nitrogen (NPN), free-amino nitrogen (-NH2-N), glycogen, lactic acid and inorganic phosphorus in addition to the subjective tests. No significant difference in the spoilage pattern of the species during ice storage was observed and these species could be preserved in ice in organoleptically acceptable condition upto 8 days, 9 days, 8 days and 11 days respectively.

237. PILLAI (V K)

Handling of fish in relation to quality. *Souvenir, Central Institute of Fisheries Operatives*, Cochin, 1970: 24-27.

In this paper the author has high-lighted some of the important points for utmost care in handling of fish. Proper cleaning of the boat deck and fish containers, immediate washing, beheading and icing of the catch, quick tansportation by refrigerated trucks, preprocess preparation at peeling sheds which maintain strict sanitary conditions, processing in quickest possible time in the factory under ideal conditions of sanitation using clean water and ice at all stages and storage at temperatures below-20°C are some of the steps which ensure products of standard quality.

238. PILLAI (V K)

Better technology for handling and preservation of fish. *Indian. Farming.* 19 (10), 1970 : 38-39.

This paper reviews and discusses the ideal methods of fish handling and preservation techniques which should be adopted for getting high quality fish.

239. GOVINDAN (T K)

Problem of leaching in iced fish. *Indian Fd. Packer* 25 (1), 1971: 27-32.

Leaching losses in iced fish are heavy especially in those containing higher levels of water extractable protein and

non-protein compounds like the groups of crustacea and mollusca. This problem deserves special consideration under our conditions as our country has a flourishing prawn processing industry employing plenty of ice for preservation and meltage of ice is maximum in a tropical country like ours. Taking into consideration the tremendous losses in solids and hence nutritive values during preservation of prawns in ice, the processor must reduce the pre-process storage period in ice to the minimum so as to retain the maximum nutrients and flavour-bearing compounds and thereby to maintain high overall quality of the processed product. This phenomenon also interferes with the spplication of the routine and traditional spoilage indices like trimethylamine, total volatile nitrogen, votalile acid number and total bacterial plate counts to such fishes, because the first three constituents being highly miscible with water are easily washed away by melting ice and the micro-organisms are partly destroyed or inactivated by the low temperature and partly washed away in the above manner. This leaves only organoleptic characteristics and some other indices resulting from the phenomenon of leaching for determining the quality of such material.

240. RAO (C V N), PRABHU (P V) and VENKATARAMAN (R)

Thermal insulation boards from coconut pith. *Fish Technol.* 8 (2), 1971 : 185–188.

Processing techniques and physical characteristics of thermal insulation boards prepared from coconut pith using rubber latex as the binding agent are reported in this communication.

In view of the easy processing, low cost and comparable physical properties with other insulating materials available indigenously manufacture of these boards appears to be promising.

241. SURENDRAN (P K) and MAHADEVA IYER (K)

Use of antibiotics in the preservation of prawn. *Fish Technol.* 8 (1), 197 : 55–60.

The present study was undertaken with a view to understanding the effect of incorporating chlorotetracycline (CTC) in ice up to 5 ppm. level on the keeping quality of prawns. From the studies it was found that CTC when incorporated in ice at 5 ppm. level could prolong the shelf life of prawn by at least six days. The use of higher levels of CTC in ice is not advisable since it would result in higher amounts of absorbed CTC in muscle, which is not completely destroyed during cooking. It is found that CTC–ice imparts a dull colour to the shell of the prawns which may have an adverse effect on their commercial value although the meats of the prawns are not affected. Since the effects of the antibiotic treatment becomes pronounced only after 8 days of storage, the use of CTC–ice would be restricted to fishing trips, where the vessel remains off-shore for more than 8 days.

242. GOVINDAN (T K) and PERIGREEN (P A)

Dressed and cooked yields of prawns in relation to duration of holding in ice. *Indian. Fd. Packer*, 26 (5), 1972 : 36–38.

The results of preliminary studies made on the influences exerted by the physical and chemical changes during ice storage on the dressed and cooked yields of prawns have been presented.

Penaeus indicus and *Metapenaeus affinis*, are the two kinds of prawns taken for the experiment. It has been observed that with regard to both moisture and salt contents of the cooked meat, the fresh (uniced) meat behaves distinctly different from meat from iced prawns in so far as it shows minimum moisture levels and maximum salt absorption. The differences in behaviour of iced material might have been caused by the changes in nature of the meat brought about by ice storage. Total organic solids in cooked meat based on P & D weight show substantial decrease during ice storage, the fall being more pronounced in the smaller size group than in the bigger one. The more the soilds leached out into melting ice, the less the amounts of the same encountered in the cooking brine.

243. GOPALAKRISHNA IYER (T S)

Essentials of fish plant sanitation. *Seafood Export J.*, 5 (2), 1973: 19-30

Some suggestions regarding organisation of sanitation programme in factories are given for getting better fishery products. Precautions to be observed during unloading catches, transportation, handling at pre-process and processing centres are detailed. Inspection techniques and microbial methods in sanitation assessments are also described.

244. SURENDRAN (P K) and MAHADEVA IYER (K)

Experimental preservation of sardines (*Sardinella longiceps*) using chlorotetracycline. *Fish., Technol.*, 10 (2) 1973: 110-115.

Effects of dips in 10 and 50 ppm. Chlorotetracycline solution on the storage life of sardines in ice have been studied and the results presented in this communication. 5 ppm. CTC ice in conjunction with dip in 10 ppm. CTC-solution has also been tried. CTC treatment considerably reduced bacterial number and gave a better appearance to the fish. The high fat content in sardines resulted in rapid development of rancidity. CTC has been found to have no control on the development of rancidity. Hence CTC treatment of sardines is found to be of limited advantage in extending the storage life of the fish in ice.

245. MADHAVAN (P), UNNIKRISHNAN NAIR (T S) and BALACHANDRAN (K K)

Review on oil sardine. I-Distribution, preservation and transportation. *Fish. Technol.*, 11 (2), 1974 : 88-92.

The authors give an account of the distribution, preservation and transportation of sardine which constitutes the single largest fishery of India.

The conventional method of preservation by icing is not as effective as with other fishes because of its high oil content. Investigations have shown that sardine can be preserved for 10-12 hours in bamboo baskets when packed with 1:1 ice and for 14-18 hours in tea chests. Frozen and glazed sardine when transported in thermocole insulated tea chests/plywood boxes can reach destination as distant as would require 4 day's journey in good condition.

246. VASANTH SHENOY (A) and JAMES (M Arul)

Spoilage of spotted seer (*Scomberomorus guttatus*) during ice storage. *Fish. Technol.*, 11 (1), 1974 67-72.

Quality deterioration of seer held directly in contact with ice, in different forms (fillets and chunks) was studied for a period of 15 days and the results are presented.

While the chunks held out of direct contact with ice were acceptable upto 13 days based on organoleptic evaluations, the chunks and fillets held in direct contact with ice were acceptable only upto 10 days. The order of preference of the samples at any interval of ice storage was chunks held out of contact with ice chunks held directly in ice fillets held directly in the ice. The changes in the chemical quality of these samples were also in the same order, the deterioration being maximum in fillets and least in chunks kept out of direct contact with ice.

247. PERIGREEN (P A), AYYAPPAN PILLAI (S), SURENDRAN (P K) and GOVINDAN (T K).

Studies on preservation of fish in refrigerated sea water. *Fish. Technol.*, 12 (2), 1975 : 105–111.

Storage characteristics of oil sardine (*Sardinella longiceps*), mackerel *Rastrelliger kanagurta*) and seer (*Scomberomorus guttatus*) in refrigerated seawater (RSW) were studied in comparison with their storage in crushed ice. Oil sardine stored in RSW was found to be comparable to iced ones only during the initial stages (upto 2 days) of storage and on further storage the former was found to be inferior to the latter. RSW can be advantageously employed for preservation of mackerel and seer which could be stored in acceptable condition for 4 to 6 days and 12 to 14 days respectively.

248. SOLANKI (K K), RADHAKRISHNAN (A G), JOSEPH (Jose) and VENKATARAMAN (R).

Ice storage characteristics of perch with special reference to its suitability for canning. *Fish. Technol.*, 14 (2), 1977 : 119-126.

Perch (*Pagnes spinifer*), one of the most abundantly available fishes of Gujarat coast was subjected to a detailed study for assessing its storage life in ice and amenability of the iced fish for canning. Changes in the salt soluble nitrogenous material and myosin content of the iced fish showed good correlation with the changes in the organoleptic and physical qualities. The fish was found to have a storage life of 9 days in ice and samples stored upto 7 days were found to be suitable for canning.

249. SOLANKI (K K) and VENKATARAMAN (R).

Ice storage characteristics of fresh and brined shark fillets. *Fish. Technol.*, 15 (1), 1978: 7-11.

The paper reports the ice storage behaviour of shark fillets in and out of contact with ice with special reference to the effect of brining and the removal of urea. The changes occurring in biochemical constituents, physical qualities and bacterial counts of the fillets are reported. Shelf life of brined fillets out of contact with ice was found to be considerably longer than that of control samples under similar conditions. Icing of shark fillets is suggested as a method for the removal of urea on a commercial scale.

DRYING, CURING & SMOKING

250. VALSAN (A P), REJENDRANATHAN NAIR (M) and SURYA NARAYANA RAO (S V)

Propionic acid as a preservative for cured fish products. *J. Sci. & Ind. Res.*, 20 D (9), 1961 : 351–354.

The possibilities of employing chemical preservatives as adjuncts to the conventional methods of preserving cured fish have been explored.

Effect of preservatives such as propionic acid, citric acid, boric acid, sodium benzoate and ethyl gallate on the shelf life of salted and dried mackerel was studied. Shelf life of wet salted mackerel using sodium nitrite, sodium benzoate and propionic acid and the effect of sodium nitrite and propionic acid on pickled mackerel were also noted.

Of the various chemicals tried, propionic acid was found to be most promising when used for wet salted and pickled fish. It helps to supress completely the growth of moulds and red halophiles which constitute the major causes of spoilage in cured fish.

251. LEKSHMY (A), GOVINDAN (T K) and PILLAI (V K)

Studies on the quality of dry prawn. *Indian. J. Fish.*, 9 B (1), 1962 : 1–6.

The variations in the quality of commercial sample of dry prawn and the effect of different moisture levels on the quality and shelf life of the products during storage were studied in detail.

Examination of physical features showed that the batches which are deshelled and graded by hand contained less of shell particles and broken pieces. The chemical constituents of commercial samples showed wide fluctuations. Samples having higher moisture contents showed discolouration and mite and fungal attack. The maximum shelf life of the samples was 1 to 1½ months. Samples having low moisture content had longer shelf life

252. RAO (S V S) and VALSAN (A P)

Improvement in quality and storage life of pickled fish by means of propionic acid. *Indo-Pacif. Fish. Coun*, section 11, 1962 : 315–317.

An indigenous pickling method known as the Colombo cure has been compared to a chemical method of pickling using propionic acid.

A dip in propionic acid was found to be more efficient than the use of acidic fruits like *gorukapuli* or tamarind. The method also delayed spoilage by moulds and red halophiles and overall shelf life was found to be doubled.

253. SURYANARAYANA RAO (S V) and VALSAN (A P)

Control of mould growth and reddening in salted and dried mackerel. *Res., & Ind.* 7 (9), 1962. 304 – 306.

Reddening caused by halophilic bacteria and growth of moulds constitute the main types of spoilage in salted and dried fish. Tne earliest symptom of microbial spoilage is mould growth followed by reddening. Chemical examination confirmed the visual findings. Spoiled products showed total volatile ni-

trogen values above 100 mg. Propionic acid dips for 10 mts at different concentrations were tried after washing and dressing the fish. Propionic acid at a level of 4% has been suggested as an effective chemical preservative for salted and dried mackerel. Mould growth and reddening could be brought under control up to 62 weeks in samples treated with propionic acid as against a normal shelf life of 15–20 weeks in the untreated samples.

254. SURYANARAYANA RAO (S V) and VALSAN (A P)

Pickling of mackerels in tropical countries using propionic acid as preservative. *First International Congress on Fd. Sci. & Tech.*, London 1962.

Pickling of mackerel in saturated brine under tropical conditions was attempted and after ascertaining that brine alone is ineffective in preventing spoilage, propionic acid was tried as a chemical preservative. In brines containing 0.5% and 1.0% of the acid, mackerel could be stored for prolonged periods. Significant improvement was also noticed at 0.25% level. Propionic acid protects the fish effectively against moulds, red halophiles and other spoilage symptoms observed in indigenous cures by traditional methods using acidic fruits us adjuncts to salt. Chemical findings support organoleptic observations. The results of a laboratory investigation and a pilot experiment on a semi-commercial scale have been described.

255 SURYANARAYANA RAO (S V), VALSAN (A P), KANDORAN (M K) and NAIR (M R)

Storage behaviour of salted and dried fish in relation to humidity conditions. *Indian J. Fish.* 9 (2) B 1962 : 156–161.

Apart from studying the general keeping quality of dry salted fish stored under different relative humidities with particular reference to the onset of spoilage caused by moulds and red halophiles, an attempt has been made to determine the equilibrium moisture curve of the samples under these conditions.

It has been found that the equilibrium moisture curve obtained for dry salted cat fi h is comparable with that obtained by Canadian workers for light salted cod. Earlier report by Indian workers recommending the moisture level of 37.5% for efficient packing of cured fish appears to need revision in the light of the present findings which reveal that drying up to moisture level of 25% would be necessary to prevent attack by moulds.

256. PRABHU (P V), SWAMINATHAN (M), VENKATARAMAN (R) and BOSE (A N)

Investigations on dehydration of some commercial fish in India. *Indo-Pacif. Fish. Coun. Curr. Affairs Bull.*, 370. 1963.

Experiments to study the possibilities of artifical drying of some commercial Indian fish have been reported. A pilot (artificial) dryer in which temperature and relative humidity (R H) could be controlled and operated by electrical energy has been utilized for these studies.

Fresh and fresh salted fish give an initial constant rate drying period which continues till the moisture content of fish tissues comes down to about 60%. The optimum temperature of drying of

fish like mackerel, lean sardines etc. has been found to be 45°C. For salt cured fish, no constant rate drying period exists. Drying time to reduce the moisture to 20 to 25% for fresh (original moisture 75 to 80%) was found to be 30 hrs, while for salt cured fish (original moisture content 60 to 65%), it was observed to be about 24 hrs.

257. VALSAN (A P)

Simplified method of pickling mackerel using propionic acid. *Indian J. Fish.*, 10 1, (B) 1963 : 1-3.

The paper reports results of investigations carried out to simplify the procedure for pickling mackerel by directly dumping split fish into saturated brine fortified with 0.25 and 0.5% propionic acid. The merits of the method over traditional salt pickling and Colombo method of curing are also discussed.

258. VALSAN (A P)

Improvement in the chemical preservation of cured fish products. *Indian J. Fish* 10 (2) B 1963: 9-10.

The salient features of the improvement achieved in the preservation of cured fish by the application of harmless chemical preservatives are described in this paper.

The treated products from dry cured fish have been found in good condition free from red mould and other visible signs of spoilage up to a period of 9 to 12 months. The wet cured fish similarly treated with preservatives remained in good condition till about 3 months as against their normal shelf life of about 2 weeks. Preliminary trials have shown that apart from samples prepared in the laboratory, the treatment was effective when tried on samples collected from cured fish markets and from commercial fish curing centres. The extension of storage life obtained in these cases has been found quite encouraging.

259. BALACHANDRAN (K K) and BOSE (A N)

Dehydration of prawns by rotary dryers. *Proc. Indo-Pac. Fish. Coun.*, 11 (2) : 1964 : 272-277.

The paper describes a successful method of drying prawns using rotary dryer. The method does not require blanching. The dried samples get deshelled and deveined during the process of drying itself and the products were found to possess characteristic colour and shape.

Fresh marine prawn could be dried to 15% moisture content. For optium drying, temperature of air inside the dryer was kept above 70°C. The speed of rotation of drum was kept at 10-15 r. p. m. initially and then raised to 30 r. p. m. for proper and quick removal of shell and veins.

260. KANDORAN (M K), SURYANARAYANA RAO (S V) and VALSAN (A P)

Studies on the effect of impurities on the penetration of salt in the curing of fish. *Indian J. Fish.* 11 (1), B, 1964: 1-8.

The effect of impurities such as calcium, magnesium and sulphate salt on curing mackerel and sciaenids was studied. The levels of 0.25 to 0.75% of calcium and magnesium and 0.5 to 2.0% of sulphate in pure sodium chloride

were tried and it was found that the rate of penetration of salt had no relationship to the calcium and magnesium contents even at a level of 0.75%. There was no evidence of enhanced spoilage due to the presence of calcium and magnesium salts during the process of salting. The presence of calcium however appeared to slightly retard the rate of drying.

261. BALACHANDRAN (K K) and BOSE (A N)

Dehydration of prawns in tunnel dryers. *Fish. Technol.*, 2 (1), 1966 : 126–130.

The paper deals with dehydration of prawns using a tunnel dryer. Conditions required to produce an end product of desired colour, shape and texture as well as good reconstitution and organoleptic properties have been worked out.

An initial temperature and relative humidity of 90°C and 85% – 90% respectively and an air velocity of not more than 1 metre per second are the essential conditions required. Both temperature and relative humidity are to be reduced to 70°C and 40% respectively after about an hour's operation till the drying is complete. The drying time required to reduce the moisture content of fresh prawn to 15% level was found to be about 7 hours.

262. KANDORAN (M K), GOVINDAN (T K) and SURYANARAYANA RAO (S V)

Some aspects of curing of sharks and rays. *Fish. Technol.*, 2 (2) 1965: 193–197.

A simple technique of desaltation of the originally salted flesh has been found to give promising results in the removal of urea from the flesh of elasmobranch fishes.

During desalting the excess salt in flesh along with the urea comes out. The desalted sample however, has to be resalted before drying. The method provides longer shelf life for the cured product.

263. APPURAJ (V E) and VALSAN (A P)

Observations on the inhibitory effect of Sodium chloride on moulds met with in smoked fishery products. *Fish. Technol.*, 3 (2) 1966 : 158–159.

The main source of spoilage in smoke cured products is the early setting in of a vigourous growth of moulds. The inhibitary action of sodium chloride on the development of moulds in smoked fishery product has been studied. Fresh oil sardine eviscerated, washed and then soaked in saturated brine for 15 minitues was then drained and smoked at a temp. of 80 – 90°C for a period of 4–6 hours. Smoked samples had a moisture content of 25 - 40%, salt content of 3.5 – 4% and fat content of 14–18%. The effect of sprinkling of finely powdered pure sodium chloride in the proportion of 1:8 (salt:fish) was ascertained.

The control sample without any salt sprinkling was affected by a vigorous growth of moulds within a short period of 3–5 days. Samples sprinked with sodium chloride was unaffected even after a storage period of 2 months. Only the rancidity of the sample had considerably increased. The study indicates that the moulds which usually affect the smoked products are not the halophilic or halotolerant types.

264. GOVINDAN (T K)

Some suggestions to improve our fish curing industry. *Seafood Export*. J. 1 (8 & 9), 1966-67: 19-22.

Curing includes sun-drying, salting, pickling, smoking, artifical dehydration etc. and comprises all the methods of preservation other than refrigeration and canning. There is need for modernising curing industry. The following is a flow sheet of the different operations and the construction of the shed must be so planned that the operation can be performed continuously. Washing tank for fresh fish ——> gutting and filletting table ——> washing tank for dressed fish ——> draining platform for cleaned fish ——> balance for weighing salt and fish ——> salting and pickling tanks ——> washing tanks for salted fish ——> draining platform ——> drying platform.Raised platform must be provided for drying preferably crow proof. If the quality of our cured fishery products is improved we can catch good foreign markets and get attractive returns besides developing a good market inside our country.

265. KANDORAN (M K), VALSAN (A P) and UNNIKRISHNAN NAIR (T S).

Occurrence of a deeper red colour in prawn pulp prepared from iced prawns. *Fish. Technol.* 4 (2), 1967: 85-88.

In commerce great importance is given to the colour of the dry prawn pulp in its quality evaluation. The possible correlation between the colour factor and the iced or uniced conditions of the raw prawn used was investigated. The study reveals that as the icing period of the raw material increases, the colour of the finished product intensifies proportionately to bright red, compared to light brownish yellow or orange colour of the product from the uniced prawn and at the same time all the other characteristics like flavour and taste deteriorate as the period of icing advances. This finding tends to show that the colour factor does not reflect the true quality of prawn pulp. Based on chemical data it is suggested that "browning" due to Maillard reaction may have an important role in this colour phenomena.

266. RAO (C V N), BALACHANDRAN (K K) and GOVINDAN (T K).

Measurement of moisture in dry cured fish by infrared irradiation. *Fish. Technol.*, 4 (1) 1967 : 28-34.

Infrared drying techique can be succsessfully applied for quick determination of moisture contents in cured as well as fresh muscle especially when a large number of samples have to be analysed the same day as in the case of preshipment inspection. With an infrared source of 150w kept at a distance of 60 mm from the sample, the time required for drying a sample of 10g. was found to be 30 minutes. Increasing the wattage of the lamp to 250 and decreasing the distance of lamp from the sample both caused over-heating of the sample. This method is found applicable to fresh, salted, unsalted and dried fish.

✓267. BALCHANDRAN (K K) and BOSE (A N)

Further studies on dehydration of prawns in rotary drum dryer. *Fish Technol.*, 5 (1). 1968 . 49-52.

The paper deals with studies on drying of prawns in rotary drum dryer. Prawns belonging to any species except

M. Monoceros can be satisfactorily dried. In the case of medium and big size prawns beheading was done prior to drying.

In all size groups beheading prior to drying resulted in better appearance of the end product in addition to the increased output of the dryer per charge. The optimum capacity of the dryer was found to be 20 Kg beheaded prawns equivalent to 35-40 Kg of whole prawns.

268. GOVINDAN (T K)

Accelerated freeze drying: A revolutionary technique. *Sci. Rep.*, 5 (8) 1968: 393-395.

In this technique, the material is actually sandwiched in between heating plates with a layer of expanded metal sheet above and below to faciliate removal of vapour easily. Bv this method drying is accelerated, hence the term 'accelerated freeze drying' (AFD). Compared ro frozen products, AFD materials are very light and hence handling and freight charge are considerably less. Once the freeze dried products have been properly packed, they can be stored, transported and distributed at ambient temperatures. AFD products are likely to be well accepted in our markets.

269. GOVINDAN (T K)

Accelerated freeze drying, the latest development in food preservation: *Ind Fd. Packer*, 22 (5), 1968: 29-32.

Raw fish are prefrozen before charging into the freeze dryer. In the case of pre-cooked material, evaporative of in situ freezing can be done by loading the material and pulling down the vaccum quickly when the water from the surface of the material evaporates and the latent heat of evaporation is taken from the material itself which consequently freezes. Evacuation can be done by a vacuum pump, but under commercial conditions steam jet ejectors may be more economical. When the vacuum in the chamber is less than 1.0 mm and temperature of material 15 to 20°C, heat is applied by electricity or steam. Drying is generally finished at a temp. of 30 to 50°C so that the last traces of water vapour are removed.

The freeze dried product is highly porous and brittle. The vacuum in the chamber is broken with some inert gas like nitrogen or carbondioxide which fills the empty spaces left behind by water. The moisture content of the product is 1 to 3% and hence the material is to be packed in air tight containers. After packing the products can be transported, stored and distributed at ambient temperatures and hence the higher cost of processing can be compensated by this factor.

270. GOVINDAN (T K), AYYAPPAN PILLAI (S) and TUCKER (Charles Gordon)

Freeze drying of fishery products: I - Drying characteristics of some common Indian food fishes. *Res & Ind*, 13 (4) 1968: 203-206.

The amenability of prawns (*Penaeus indicus*) oil sardine (*Sardinella longiceps*) Kilimin (Nemipterus japonicus), Mullet (*Mugil Sp.*) Kalava (*Epinephelus sp.*) and golaree (*Nemipterus japonicus*) to preservation by freeze drying has been studied. The effects of pre-freezing, evaporative freezing and presence of fat in the fish on the drying rates and reconstitution properties of the freeze dried stuff have been assessed.

Prawn and lean fish yielded products with good reconstitution and organole-

ptic properties. High fat contents in the fish retard both dehydration and rehydration.

The product obtained by pre freezing is superior to that obtained by evaporative freezing with respect to reconstitution behaviour and organoleptic properties.

271. BALACHANDRAN (K K)

Accelerated method of hot air drying in fish. *Fish. Technol.*, 6 (2), 1969: 124-128.

The effects of temperature and relative humidity on the rate of drying of split open and salted fish in a tunnel dryer have been studied at a constant air velocity. Several experiments were carried out at temperatures ranging from 40°C to 60°C keeping both RH and air velocity constant at 50% and 130 linear m/min respectively, the latter two being selected at random.

By a judicious combination of temperature and relative humidity, the rate of drying could be considerably accelerated. In the case of mackerel, lactarius, otolithes and kilimeen the time required for drying to moisture levels below 30% was found to be 10 to 12 hours. High temperatures accelerated drying of fish considerably but temperatures above 50°C caused a certain amount of cooking of the muscle. The lower the RH, the higher was the rate of moisture loss; but RH below a certain level resulted in case hardening.

272 GOVINDAN (T K)

Freeze drying of fishery products: II. Development and freeze drying of precooked, ready - to- serve fish salads. *Res. & Ind.*, 14 (3), 1969: 120–121.

Wholesome precooked, ready to serve salads were prepared from prawns, seer, tuna and kalava incorporating emulsified vegetable oil for increasing their calorific value. The salads were spread in uniform layers on the trays, frozen and freeze dried. The maximum material temperature was limited to 40°C.

The freeze dried salads turned out to be crisp, very tasty and acceptable and were unanimously judged to be quite wholeome by a taste panel.

273. GOVINDAN (T K),
AYYAPPAN PILLAI (S) and
TUCKER (Charles Gordon)

Prospects of freaze drying in India. *Indian Fd. Packer*, 23 (5), 1969 : 27–30.

Freeze drying has become an accepted method of food preservation and is gaining more and more popularity because of several advantages it offers to the housewife. In India, freeze drying holds out a promising method of food preservation in so far as frozen stuffs require maintenance of chain of cold storages and refrigerated transport at –18 to –23°C which is costly and hence adds to the price of the food material. Freeze dried product is very light and when once packed properly, it no longer requires any refrigeration and thus saves a lot in this way compared to frozen products. One serious defect of freeze dried foods at present is that the capital and processing costs are considerably high which are reflected in the cost of the finished product.

274. GOVINDAN (T K)

Our fish curing industry. *Indian Fd. Packer.*, 23 (1), 1969: 23–37.

Drying of fish either alone or in combination with salting or smoking or both and several modifications of the salting processes like wet salting, pickling, fermentation etc., are together termed fish curing. The author gives an account of the different methods of fish curing that are followed in the industry, the present condition of the industry, the important defects in the cured fish products and ways and means of modernising the industry with suitable recommendations on them.

275 GOVINDAN (T K)

Studies on salting and drying of fish with special reference to changes in nitrogenous constituents. *Indian Fd. Packer*, 23 (4), 1969: 18–22.

Changes occurring in moisture, NaCl, salt extractable nitrogen, non-protein nitrogen and free amino-acid nitrogen in dressed sardine and mackerel during heavy salting for short and prolonged periods and subsequent drying as well as pickling in saturated brine have been studied and results reported. The weight loss due to loss of water (*Ca* 27.5 ml/100g of dressed fish) during heavy salting of sardine and mackeral was made good to the extent of *Ca* 50% by the absorption of salt by the muscle. A certain amount of proteolysis was also indicated as shown by the higher NPN and free amino-N values. Loss in salt extractability was rapid during the drying stages of the heavily salted sardine which slowed down and processed at a much slower rate during storage. During pickling of heavily salted mackeral in saturated brine, moisture content of the muscle attained a steady value of 60% and drastic loss in salt extractability of proteins took place in pickle. SEN reaching a minimum value of *Ca* 2% in 9 days which was maintained throughout the rest of the storage period.

276 KAIMAL (P N R) and BALACHANDRAN (K K)

Dehydration of prawns *Food Ind. J.* 3(4), 1969: 5–9.

In order to produce dry prawn of standard quality, it is essential to adopt artifical drying technique. The product turned out in the rotary drum dryer designed by the C I F T meets the requirements of quality more than what specified. All the disadvantages and defects of the traditional method of production of dry prawn are overcome by the use of the above dryer. Cooking, dehydration and deshelling of prawns are carried out in a single operation in the dryer. It has also been observed that if the material is dried in the beheaded form the final product would be brighter in appearance. A clear picture of the operational procedure of the rotary drum dryer for dehydration of prawns and the estimate for the cost of production of dry prawn in it are the high-lights of this paper.

277. KANDORAN (M K), SOLANKI (K K) and VENKATARAMAN (R)

Studies on the storage behaviour of laminated and commerical Bombay duck. *Fish. Technol.*, 6 (2), 1969: 140–147.

This work deals with control of discolouration of laminated Bombay duck and the optimum humidity level at which the commercially dried fish would have maximum shelf life.

Among various chemical preservatives tried, only BHT and NDGA in concentrations of 0.10% in the brine considerably

retarded discolouration and extended the storage life of laminated Bombay duck. It was found that a level of about 65% R H provided maximum shelf life to the commercial Bombay duck during storage

278. GOVINDAN (T K)

Freeze drying of fishery products: III. Preparation of instant fish soup mixes and prawn cake and their preservation by freeze drying. *Res., & Ind.*, 15 (3), 1970: 162-163.

This paper deals with the development of instant soup mixes from two common varieties of fishes, viz. seer (*Scomberomorus sp.*) and kalava (*Epinephelus sp.*) and a fish cake from canned prawns, and their preservation by fraeze drying. The preparations show good keeping qualities after freeze drying. Various items prepared from the preserved mixes and the cake have excellent consumer acceptability.

279. GOVINDAN (T K)

Preservation of food through dehydration. *Food Ind.,J.*, 3 (10), 1970: 4-7.

The process of removal of water from any substance is called dehydration. The most important purpose served by dehydration is to bring the moisture content of the meterial below that which is required for microbial growth and proliferation which is 10 to 15% for most of the food maferials. Another purpose served by this process is the reduction in weight making transportation and distribution of the food materials easier and cheaper. A third advantage is the denaturation and inactivation of the enzymes naturally present in protein food especially, which otherwise cause deterioration. Two types of dehydration viz. sun drying and salt curing are adopted for preservation of fish. Experiments have shown that the faster the rate of dehydration, the better the reversibility of the process. Hence artifical dehydration under accelerated conditions came into usage. Accelerated freeze drying is the latest and most sophisticated method ever to be employed for the dehydration of food stuffs.

280. MATHEN (Cyriac).

Quality and shelf life of dried sharks produced in India. *Fish. Technol.*, 7 (2), 1970: 213-215.

This paper deals with the quality and shelf life of dried sharks produced in India. It is suggested that uniform methods of salting and curing be followed to minimise quality variation. Salting shark flash in the ratio of 1:3 and allowing to cure in self brine for more than 12 hours followed by drying gives a product with satisfactoty shelf life.

281. SOLANKI (K K), KANDORAN (M K) and VENKATARAMAN (R).

Studies on smoking of eel fillets. *Fish. Technol.*, 7 (2), 1970 : 169-176.

The effect of various factors such as source of smoke, the size of fillets, concentration of brine, period of brining, pre-drying, smoking, and final drying on the quality of smoked product was studied in detail and the results obtained are enumerated in this communication. A method is suggested for the preparation of an excellent smoked product from eel fish. Best quality of smoked product is obtained on smoking eel fillets with a mixture of coconut husk and sag sawdust in 1:1 proportion for

15 hours. Optimum moisture level of the final product was fixed in the range of 30 to 35% and it had a storage life of about 8 months at room temprature. The product had attractive reddish colour, pleasant odour and very palatable flavour.

282. RAMANANDA RAO (D) and KAMASASTRI (P V)

Quality of fish meal processed from sun-dried fish in a commercial fish meal dryer. *Fish. Technol.*, 8 (1), 1971 : 51-54.

The physical and chemical compositions of the raw materials received and the composition and nutritive values of the finished products in a commercial size fish meal plant employing the dry rendering process were studied. The protein quality index varied from 62.33 to 75.52. The available lysine was also of lower order as the fish had already been subjected to sun drying prior to its processing to meal.

283. RAO (C V N), PERIGREEN (P A) and BALACHANDRAN (K K).

Determination of salt content in cured fishery products by electrica. methods. *Indo-Pacif. Fish. Coun Occ. Pap.* 71/4 1971.

Two quick electrical methods have been developed and standaradised for routine inspection of salt content in cured fishery products, based on the measurement of sodium ion activity and electrical conductivity of their aqueous extracts. Results compare favourably (+ 5%) with the values obtained by chemical method.

284. UNNIKRISHNAN NAIR (T S) and VALSAN (A P)

Time lag between the catching and curing of fish and its influence on the finished product : mackerel. *Fish. Technol.*, 8(1), 1971: 12-18.

The time lag between the catching of mackerel (*Rastrelliger kanagurta*) and its curing after uniced and iced storage conditions were studied.

Based on the physical, chemical, bacteriological and taste panel studies, the maximum permissible time lag was found to be 8 hours under uniced condition and 3 days under iced condition.

285. PRABHU (P V)

On sun-drying of Bombay duck. *Fish Technol.*, 9 (1), 1972 : 64-67.

Considering the magnitude of the fishery and the trade potential of the dried products, standardisation of procedures for preservation and processing of Bombay duck was found to be an urgent need.

Sun-drying of Bombay duck by hanging on scaffolds gave better products than those obtained by drying them in trays. Optmum rate of drying and quality of dried product were obtained when the fish were suspended at the rate of 50 to 60 per metre length of the rope. The quality of the raw material as effected by the delays in different hauls in the fishing trip was reflected in the dried products also.

286. VENKATARAMAN (R) and SOLANKI (K K)

Drying and laimination of Bombay duck under hygienic conditions on a commercial basis. *Symposium on Marine Fisheries Research*, Gujarat, 1972.

A process of the large scale commercial manufacture of laminated Bombay duck by a 1 tonne artifical tunnel dryer designed by CIFT has been described.

287 GOVINDAN (T K)

Freeze drying and its applications in fish preservation. *Seafood Export J.*, 5 (1), 1973: 139-148.

Freeze drying is used to denote removal of water by artifical means under carefully controlled conditions. When the expelled water is supplied back to the dried material a product nearest in qualities to the original material in appearance, odour. flavour, texture and nutritive value is obtained. The principle involved in this method is sublimation of ice. When ice is kept under a sufficiently low vacuum and heat is supplied, it sublimes is molecules of water escape from the surface. Sublimation is allowed to proceed keeping the tempe ature of the material at subzero levels until 90% of the water is removed. The processed material is packed in air – tight containers under inert atmosphere. The advantages of freeze drying for fish are discussed.

283. GOVINDAN (T K)

Freeze drying of fishery products : IV–Biochemical changes occurring in prawn muscle during freezing, freeze drying and prolonged storage of the freeze dried product. *Fish. Technol.* 11 (2), 1974 : 145–150.

The changes occurring in water and salt extractable protein and non protein fractions in prawn muscle of different species during freezing, freeze drying, and subsequent prolonged storage have been studied and results are presented. It was found that while there was no denaturation of water extractable proteins due to freeze drying, salt extractable proteins were rendered insoluble to the extent of 21%. The freeze dried products remained in good edible condition for 32 months of storage.

289 KANDORAN (M K) and VALSAN (A P)

Packing of cured fish in India: Existing methods and suggestions for improvement. *Seafood Export J.*, 6 (5). 1974: 27–31.

Investigations were conducted by the authors on the characteristics of the packing materials commonly employed and the results of the experiments are presented in this paper. The studies were carried out on cured mackerel. (*Restrelliger Kanagurta*).

Taking into consideration the merits and demerits of the differenf packaging materials, they can generally be listed in the order of their efficiency as, deal wood or plywood boxes, tarpolythene lined gunny bag, palmyra palm leaf or screw pine leaf mat, gunny bag, cardboard waxed cartons, bamboo baskets and coconut palm leaf mat.

The loss and deterioration due to dehydration or rehydration can be successfully controlled when the packing material is given an internal lining of polythene, which makes the package more moisture proof.

290. VALSAN (A P)

Our fish curing Industry : Some new techniques to improve it. *Seafood Expert J.*, 6(9), 1974 : 21–27.

The results of experiments conducted to

control spoilage during storage of cured fish is presented.

A simple method consists in sprinkling or dusting refined salt containing 3% sodium propionate on the finished cured product in the ratio of 1:10 just before its final packing and storing. The adoption of this new technique of preservation is bound to give an economical boost to our fish curing industry.

291 BALACHANDRAN (K K)

Storage studies on prawns dried in rotary drum dryer. *Fish. Technol.* 12 (2), 1975: 116-119.

Storage study carried out with prawns processed in rotary drum dryer showed that the deteriorative changes taking place are mostly due to the presence of air and oxygen. By storing under inert atmosphere of nitrogen or carbon-dioxide, the original characteristics can be maintained over a considerable length of time. At the end of 20 weeks storage the sample packed under air showed some discolouration and loss of flavour, where as those under nitrogen and carbon-dioxide remained without appreciable change. Dry prawns packed under air in sealed can could maintain the quality up to 5-6 months but for slight loss in colour and flavour, while inert atmosphere maintained the material in good condition for a longer period.

292. BALACHANDRAN (K K) and MURALEEDHARAN (V)

Studies on Colombo-curing of mackerel (*Rastrelliger kanagurta*) *Fish. Technol.*, 12 (2), 1975 : 145-150.

Colombo curing is a preservation method followed by fishermen of Malabar and South Kanara coast. The method consists in rendering the brine acidic by rubbing salted *gorukapuli* (Malabar tamarind) on gutted and washed fish. The heavily salted fish are kept in large cement tanks under self brine for some weeks and later packed in air tight barrels under saturated brine and exported. Results of investigations carried out to improve the process of Colombo-curing of mackerel are presented in this paper. The sample treated with salt in the ratio 1:5 and *gorukapuli* at the rate of 45g kg of fish and sodium benzoate at 0.5% gave a product having very good storage life and organoleptic characteristics. *Gorukapuli* acts as a cheap indigenously available substitute in place of imported propionic acid.

293. DEVADASAN (K), MURALEEDHARAN (V) and JOSEPH (K George)

Studies on smoke curing of tropical fishes. *Fish. Technol.*, 12 (1), 1975: 77-80.

Studies on smoke curing of some of the common food fishes viz. mackerel, cat fish and sole are presented. From the results of the experiments, in all the three cases, smoked products of good appearance and taste were obtained. The turmeric treated samples had a very attractive appearance especially in the case of sole. The samples had a moisture content of 15-20% and salt content of 10-12%. The products had a high salt content which is found essential for its storage life.

294. DEVADASAN (K), MURALEEDHARAN (V) and JOSEPH (K George)

Pickle curing of fish using tartaric acid and garlic as preservatives. *Fish. Technol.*, 12 (2), 1975 : 156-159.

Tartaric acid was tried as a preservative for pickle cured fishes. By using tartaric acid, the PH is lowered without impairing the appearance of the pickled fish. The modified method consists in incorporating a little garlic in the pickled medium. Salt and fish in the ratio of 1:4 was used, to which garlic and tartaric acid in 2% of the weight of refined salt was added. The samples treated with tartaric acid and garlic remained in good conditions for more than 16 weeks, where as samples without these spoiled within 8 weeks.

295. GOVINDAN (T K)

Freeze drying fishery products : V-Storage chacteristics of ready-to-serve freeze dried foods. *Fish. Technol.*, 12 (1). 1975 : 35–36.

Behaviour of freeze dried ready-to-serve fish based food preparations during prolonged storage at room temperature has been studied and reported in this paper.

Storage life of such products under the conditions employed in this study can be reckoned in years at ambient temperatures.

296. VALSAN (A P)

Comparative yield and biochemical evaluation of existing fish curing methods of India. *Symposium on Fish processing Industry in India*, Mysore, 1975: 53.

The biochemical quality of fresh fish and the changes they undergo when processed by different methods of fish curing currently practised in India are studied in detail. The fish curing method studied were sun drying, dry curing, mona curing, wet curing, pit curing, Colombo curing and smoke curing. The parameters assessed were moisture, NaCl, ash, insolubles, calcium, phosphorous, iron, TVF, TVN, TMA, total N, water soluble N, non-protein N, amino N, fat, peroxide value, total bacterial count and reconstitution properties.

297. BALACHANDRAN (K K) and VIJAYAN (P K)

Processing aspects of Indian mackerel: A review. *Fish Technol.*, 13(2), 1976 81–87.

The method of capturing of mackerel, seasonal landings and utilitsation by curing process, use of sodium propionate, mixture of potassium sorbate, sodium benzoate, sodium acid phosphate and common salt are detailed. Preservation processes like canning and freezing are also discussed.

298. MURALEEDHARAN (V) and VALSAN (A P)

Preparation of smoke cured fillets from oil sardine. *Fish. Technol.*, 13(2), 19 6: 147–152.

A method of preparation of smoke cured fillets from oil sardine is described. Various procedural steps like brining, smoking, packaging etc. have been described and the shelf life assessed Sodium propionate treatment is recommended to enhance storage life, BHA to control rancidity, and thermal treatment to overcome insect infestation The product has good consumer appeal.

299. DEVADASAN (K) and VENKATARAMAN (R)

Smoke curing. *Sea Food Export J.*, 9(1), 1977: 51–56.

Smoke curing is an age old fish preservation method. The method seems

worthy of popularisation in our country also as it is ideally suited to our conditions requiring comparatively very little initial investment. All chemical components of smoke have not been understood. However, four fractions have been isolated from smoke. Wood smoke is known to have a pronounced antioxident activity which can prevent rancidity. This is attributed to guaicol and its homologues found in smoke. The attractive colour of smoked fish is supposed to be due to the phenols present in smoke The effect of smoke on pure cultures and on the microflora of fish are different. In general, the bacterial action of smoke can be said to be dependent on the content of formaldehyde, phenols, organic acids etc.

300. DEVADASAN (K), MURALEEDHARAN (V) and JOSEPH (K George)

Influence of fat content on the quality and shelf life of cured sardines. *Fish. Technol.*, 14(1), 1977: 73–77

The paper presents results of studies on the effect of seasonal variations of the fat content on the quality and shelf life of dry cured, pickle cured and smoke cured oil sardines. The merits and defects of each method of curing during different seasons are discussed.

It was found that products prepared out of fish with low fat content had better shelf life compared to those prepared from fatty fish. Sardine caught from August to November and from March to June had less fat content when compared to those caught during November to January. Curing is advocated for sardines with less fat content, while pickling is a good method for oil sardine when fat content is more. Sodium benzoate added while pickling enhanced the storage life.

301 VALSAN (A P)

Role and importance of fish curing in the utilisation of low priced fish part I & II *Proc. Training Programme in utilisation of low priced fish*. CIFE, Bombay, 1977.

The problem of utilisation of low priced fish has gained considerable significance. Fish curing includes drying, smoking, salting and pickling of fish.

Inspite of the preservative steps like salting, drying, smoking etc. cured products still undergo a gradual deteriorative change due to various causative factors like, microbial spoilage, discolouration and off odour produced by fat oxidation, spoilage by insect infestation etc. Suggestions for the improvement of curing industry is highlighted.

302. MURALEEDHARAN (V), UNNIKRISHNAN NAIR (T S) and JOSEPH (K George)

Smoke curing of mussels. *Fish. Technol.*, 16 (1) 1979: 29–31.

This paper presents the results of investigations carried out to prepare quality smoked products from mussels.

The smoked products are either sun-dried or dried in dryers to 10% moisture level. At this moisture, the products could be stored without spoilage for more than six months. The yield of the final product was found to be 22%. The proximate composition of the smoked mussels are: moisture 10.8%, Chlorides as NaCl 2.81%, total nitrogen 8.76%, Ash 11.32%. Acid insolubles 0.058%, Glycogen 22.15% and Fat 11.51%.

303 MURALEEDHARAN (V), JOSEPH (K George) and DEVADASAN (K)

Pickled products from green mussel. *Symposium on Coastal Aquaculture* Cochin, India. 12th – 18th January 1980.

Methods of preparing different types of delicious ready – to – serve pickled products from green mussel *Perna viridis* and a comparative study of their storage charcteristics are reported. Of the three types of products, viz., dried and pickled, fried and pickled and light smoked and pickled, the last one had the best shelf life. The optimum conditions of drying and smoking for preparing such type of pickles are also reported.

304 NARAYANASWAMY (D), NARASIMHA RAO (C V) and GOVINDAN (T K)

Penetration of Sodium chloride during prolonged salting of fish. *Fish. Technol.*, 17 (1), 1980: 63 – 64.

Absorption of salt and expulsion of moisture in threadfin bream (*Synangris japonicuns*) jew fish (*Sciaenids sp.*) and lactarius (*Lactarius lactarius*) during prolonged salting is detailed in this communication. It was found that the greater the proportion of salt employed, the quicker was its absorption and shedding of moisture by the muscle. Temperature influences the rates of salt penetration and moisture loss, the maximum at 40°C, minimum at 10°C and in between at 28°C.

CANNING

305. CHOUDHURI (D R) and BALACHANDRAN (K K)

Preliminary studies on blanching of prawn. *Fish Technol.*, 2 (1), 1965: 139–243.

Results of studies undertaken to find out the causes of irregular drained weight conditions in commercial canned prawn samples are presented. The tendency of cooked prawn to attain the equilibrium moisture content (72–74%) in *M. affinis* and *M. dobsoni* when in contact with brine has been found to be mainly responsible for the loss and gain in drained weight. Under-blanching results in loss of moisture from the meat during processing.

It has been found that under standard conditions of salt concentration of the blanch liquor and the temperature of sterilisation, the fluctuation in the drained weight could be avoided irrespective of initial moisture content.

306: CHOUDHURI (D R)

Prevention of can interior blackening with particular relation to prawn. *Sci. & Cult*, 35 (4), 1969 : 161–163.

Blackening of food material and can interior is one of the major problems faced by canning industries all over the world. In order to control deposition of iron sulphide, acidity in the can is to be maintained properly. Methods recommended consist of blanching the prawn in salt solution having acidity between 0.15% and 0.20% and finally packing the blanched meat with salt solution in the presence of 0.1%–0.30% citric acid. The process ensures 0.1%

acidity of brine in the can. Adoption of this method eliminates blackening of prawns almost completely.

307. KRISHNA RAO (K), GOPALAKRISHNAN NAIR (R) and PILLAI (V K)

Note on the physical characteristics of canned prawns. *I. S. Q. C. Bull.*, 12 (3 & 4), 1968-69.

Drained weights of canned prawns show considerable variation over even a single day's production due to a number of processing factors. Observations made on gross weights, drained weights and volumes of brine from proceseed cans have shown highly significant correlations in most of the instances.

The correlation factors such as volume of brine from the processed can, drained weight of prawns and gross weight of canned prawns of different processing factories and the size grade of the prawns were found to be highly significant. The correlation of gross weight with volume of brine on one hand and with drained weight on the other is found to be positive, while the correlation between volume of brine and drained weight turned out to be negative. The results suggest that any consistant and significant fluctuation in gross weight can be taken as indication of non-uniformity of processing factors which requires rectification.

308. NANDAKUMARAN (M), CHOUDHURI (D R) and PILLAI (V K)

Studies on blackening of canned prawns: Influence of copper and iron on product blackening. *Fish. Technol.*, 6 (1), 1969: 49-51

A linear relationship was observed between the copper content and intensity of blackening in commercially canned prawn meat. Average copper and iron contents of unblackened canned prawn meat were 9.6 and 32.5 ppm on dry weight basis respectively. In the blackened product copper content ranged from 15.8 to 63.9 ppm and iron content between 43.7 and 71 45 ppm depending on the intensity of blackening. But incorporation of copper in the above range to experimental cans produced blackening while iron upto 250 ppm did not impart any blackening under standard conditions of canning-

309. VARMA (P R G), CHOUDHURY (D R) and PILLAI (V K)

Factors controlling drained weight in canned prawns. *Fish. Technol.*, 6 (2), 1969 : 134-139.

The problem of controlling the drained weight in canned prawn products is of paramount importance to the trade. The paper gives an account of factors controlling the drained weight in canned prawn. The most important among them are concentration of brine used for blanching and blanching time which are found to be fixed and specific for different sizes of prawn irrespective of the quality of the material used. Other factors such as acidity of brine used for filling the can, volume of brine, time of sterilization and time of cooling the blanched meat are also to some extent found responsible for fluctuations in drained weight.

310. CHOUDHURI (D R), GOPALAKRISHNA IYER (T S) and PILLAI (V K).

Factors controlling sterility in canned prawn. *Fish. Technol.*, 7 (1), 1970 : 73–80.

Probable sources of contamination of raw, blanched and processed meat at various stages of handling and methods for their rectification have been described. Inter-relationship between absolute sterility and commercial sterility with particular reference to the sanitation of the factory has been discussed.

311. MADHAVAN (P), BALACHANDRAN (K K) and CHOUDHURI (D R)

Suitablity of ice stored mackerel and sardine for canning. *Fish. Technol.*, 7 (1), 1970 : 67–72.

The results of studies on ice storage and subsequent canning of mackerel and sardines and the effect of such storage on the quality of the canned product are discussed. The changes in the physical and chemical characteristics during ice storage were determined and correlated with the quality of the finished product.

Organoleptic analysis indicated that mackerel and sardine stored in ice up to three and two days respectively can be used for commercial canning. Storage beyond this period results in poor appearance of the material, increase in spoilage indices and poor organoleptic characteristics of the canned material. Sardines stored for 5 days in ice gave a product of party consistency, but under identical storage period, the texture of canned mackerel was soft and fibrous.

312. NANDAKUMARAN (M), CHOUDHURI (D R) and PILLAI (V K)

Blackening of canned prawn and its prevention. *Fish. Technol.*, 7 (2), 1970 : 120–129.

An attempt has been made to explain the types and causes of blackening in canned prawns and methods of its control with particular reference to the quality of the material used.

It was found that blackening caused by iron sulphide could be controlled by by maintaining proper titratable acidity of fill brine in cans. The paper also elaborates the factors responsible for or governing this critical titratable acidity. With regard to copper sulphide blackening, control was found to be difficult maintaining the acidity or by additives such as EDTA when the copper content in the material went above the critical level.

313. NARAYANAN NAMBIAR (V) and MAHADEVA IYER (K)

Common microflora involved in spoilage of canned prawns. *Fish. Technol.*, 7 (2) 1970: 116–119.

An elaborate survey was carried out to ascertain the common types of micro-organisms responsible for spoilage in canned prawns. Among nearly 1500 strains isolated from bacteriologically defective cans, 60% were gram positive spore formers of the *Bascillus* type. Other types isolated belonged to gram positive *cocci*, gram negative rods, gram positive nonspore-forming rods, gram negative *cocci* and *coccoids*. No anaerobes could be isolated. The predominant gram positive sporeformers were identified as *Bascillus Pantothenticus*, *B firmus*, *B. bravis* and *B. pumilus*. The observation points out that the cause of contamination of the cans could have been leakage through seams during the cooling process.

314. VARMA (P R G)
CHOUDHURI (D R) and
PILLAI (V K)

Effect of varying water contents in oil packed sardine and mackerel, *Fish. Technol.*, 7 (1) 1970: 95-96.

The effect of varying water contents on shelf life of canned materials was studied. The changes in physical and biochemical properties of canned sardine having water content of 5% and above 25% in filled oil were noted.

Samples having higher percentage of water in the can showed comparatively lower shelf life and developed black stain on the can within 10–15 days of storage.

samples having lower percentage of water in the can exhibited higher storage life without any black stain for a period of 75 days of incubation Changes in physical and biochemical properties of canned mackerel were almost similar to those of canned sardines.

315. VENKETARAMAN (R),
KANDORAN (M K) and
RAJE (C R)

Comparative studies on the canning properties of ptomfrets and hilsa. *Fish. Technol.*, 7 (1), 1970 : 58-66.

Fresh silver pomfret, black pomfret and hilsa were canned at absolutely fresh and iced conditions and the qualities of the final products were studied in relation to the initial quality of the raw materials. Under identical conditions, a maximum quantity of cookdrip and nitrogen contents were found to be lost in black pomfret and minimum in hilsa. Silver pomfret and black pomfret iced for 3 days gave fairly good products on canning, while hilsa came out only as a satisfactory product on canning after the same period of ice storage.

316. KANDORAN (M K), SOLANKI (K K) and VENKATARAMAN (R)

Canning of smoked eel. *Fish. Technol.*, 8 (1) 1971: 98-100.

Investigations were carried out with a view to suggesting a proper method for the preparation of eel into various products like smoked and canned eel fillets. The data collected on this line are presented here. Preliminary experiments showed that the storage life of canned sample increased as the moisture content of smoked fillets decreased. Smoked fillets at moisture level of round about 50% on canning remained in good condition for 10 months after which gradual deterioration in quality took place.

317 MADHAVAN (P) and
BALACHANDRAN (K K)

Canning of tuna in oil. *Fish Technol.*, 8 (1), 1971 : 23-26.

This paper provides the experimental details of canning of tuna in oil. A detailed work was undertaken paying due atention to the various aspects of the problem with a view to turning out product conforming to the IS specifications using different sizes and species of fish, the results of which are presented.

318. RAO (C V N) and PRABHU (P V)

Heat distribution patterns in canned prawns. *Indian Fd. Packer*. 25 (4), 1971: 21–24.

Studies on heat distribution curves at various points in the can of size 301X 206 packed with 142 g of cooked prawns in 90 ml brine during the ste ilization process have indicated that the main transfer of heat to the meat is by convection currents of hot brine. The slowest heating zone was found to be 1.3 cm to 1.5 cm above the bottom on the central longitudinal axis. The heating parameters are not significantly altered by variation in initial temperature of the product and sterilization temperatures Lethality of the normal 20 minute process at retort temperature 115 5°C adopted by the factories is found to be adequate and significantly more than the minimum time required for this type of can and contents.

319. GOVINDAN (T K)

Research of fish canning in India: A review: *Indian Fd. Packer.*, 26 (1), 1972 : 25–31.

With the establishment of the fish canning industry, several technical problems cropped up, as well as the urgent need to work out methods of canning for the various types of food fishes available in our country with a view to finding better and more economic utilization of our marine resources. Research on these aspects started to be undertaken more than one laboratory in our country aimed at finding suitable solutions to the above problems, a brief review of which is given in this communication.

It may be seen that canning procedure for the important species of marine food fishes of India have been perfected. However, many of them have not yet found their way out of the laboratory. It is upto the industry to adopt these techniques with a view to diversifying their products and utilizing at least a portion of the idle installed capacity of our fish canning plants.

320. MATHEN (Cyriac)

Method for prevention of blackening and improvement of colour in canned prawns. *Seafood Export J.*, 4 (11), 1972: 7

The author endorses a method for prevention of blackening and improvement of colour in canned prawns by using a suitable additive. Addition of disodium EDTA was found to be most effective in completely preventing blackening in canned prawns. The optimum concentration was worked out to be 50mg% (w/v) in the filling brine i. e., 3% NaCl + 0. 1% citric acid.

321. MADHAVAN (P),
UNNIKRISHNAN NAIR (T S)
and BALACHANDRAN (K K)

Review on oil sardine. II-Preservation by canning, curing and smoking. *Fish. Technol.* 11 (2), 1974 : 93–101.

In order to improve the quality of canned sardine and to bring down the cost by overcoming the technological problems associated with the production and suitably modifying the packing medium, a good amount of work has been carried out at CIFT and the results of the experiments have been presented in this paper.

Higher percentage of water in filling oil resulted in comparatively lower shelf life of the canned product with increased incidence of peroxide value and free fatty acids in the oil. CIFT has worked out methods by which sardine can be packed in oil with only negligible quantity of water in the fill. Use of mixed preservatives consisting of salt, sodium-propionate and BHA has been found to be very effective in improving the shelf

life of cured product. Smoking is a process which is applicable to both lean and fatty fishes. Sardine can find good use for production of smoked products in our country.

322. UNNIKRISHNAN NAIR (T S), MADHAVAN (P), BALACHANDRAN (K K) and PRABHU (P V)

Canning of oil sardine (*Sarinella longiceps*): Natural pack. *Fish. Technol.*, 11 (2), 1974: 151-155.

A simple and economic process for canning of oil sardine (*Sardinella longiceps*) in its own juice having very good organoleptic characteristics has been developed. The process is discussed in this paper.

323. BALACHANDRAN (K K) and UNNIKRISHNAN NAIR (T S)

Diversification in canned fishery products: Canning of clams and mussels in oil. *Symposium on Fish Processing Ind. in India*, Mysore. 1975: 49

This paper details the methods to be employed for canning clams and mussels in oil.

324. GOVINDAN (T K)

Investigations on canning of prawns in brine: Effects of various processing parameters on canning characteristics, quality and drained weight of the canned products. *Symposium on processing Ind. in India*, Mysore, 1975: 48.

Effects of various factors like holding of fresh prawns at room temperature for four hours, storage of blanched prawns in ice, storage of the raw prawns in ice, duration of blanching time, storage of canned product at room temperature, intensity of heat employed for blanching and concentration of blanching brine on the canning characteristics, quality and drained weights of the products canned in brine have been studied in detail and the results reported in this paper.

325. BALACHANDRAN (K K) and MADHAVAN (P)

Canning of lactarius. *Fish. Technol.*, 13 (2), 1976:159–160.

Fresh lactarius after evisceration and cleaning was cold blanched in saturated brine containing different concentrations of citric acid, calcium chloride and alum and then canned. Comparison of the effects of different treatments tried to maintain proper texture of the meat was made. Cold blanching in saturated brine containing 1% citric acid yielded a satisfactory product.

326. UNNIKRISHNAN NAIR (T S), BALACHANDRAN (K K) and MADHAVAN (P).

Canning of smoked sardine. *Fish. Technol.*, 14 (1), 1977:49–52.

The results of experiments conducted to work out a method for canning smoked sardine are presented. Coconut husk is used as source of smoke. Cold blanching of dressed fish in brine, smoking followed by drying in hot air or cooking in steam to reduce the moisture content to the required level and subsequent canning yielded product with good organoleptic properties.

327. BALACHANDRAN (K K)

Seafood canning in India. *Souvenir Industrial Fisheries Ass., University of Cochin*, Cochin, 1978:101–102.

The availability of canned products popular in overseas markets, the products available in India and the future of seafood canning industry in India are highlighted.

328. VARMA (P R Girija) and VENKATARAMAN (R)

Canning of smoked Dhoma (*Sciaenid* sp.) *Fish. Technol.*, 15 (1), 1978: 27 - 29.

A procedure for turning out a wholesome smoked and canned product from Dhoma (*Sciaenid* sp.) has been described.

329. BALACHANDRAN (K K) and PRABHU (P V)

Preliminary studies on preservation and transportation of green mussel (*Perna viridis*). *Symposium on coastal Aquaculture*, Cochin. 12th-18th January, 1980.

Studies were undertaken on perservation in ice of whole green mussel (*Perna viridis*) and meat shucked from fresh and boiled mussels. Biochemical and organoleptic changes taking place in the meat during storage were followed to assess the shelf life. Similarly studies were also carried out on transportation of whole mussels and meat in various conditions. The results of the above studies are presented in this paper. on further processing into canned product, it has been observed that meat shucked from fresh mussels and preserved in ice yielded comparatively better product when canned in oil.

330. MATHEN (Cyriac), THOMAS (Francis) and VARMA (P R Girija)

Improved yield in the canning of prawns. *Seafood Export J.*, 12 (1), 1980: 35.

Experiments conducted in the CIFT laboratory have shown that use of phosphates for treatment of raw prawn meat can result in an increase of 5% in canned product. The method worked out is to treat the raw prawn meat with a mixture of phosphates in solution followed by blanching. Incidentally this treatment also results in better size grade of the product. The solution consists of 70 g of sodium tripolyphospate, 10 K_2HPO_4, 20 g of NaH_2AO_4 and 20 g NaCl dissolved in one litre of water. This solution can be used for the treatment of 10 Kg of prawn meat. Treated prawns are blanched for slightly higher time one minute more than the controls. Canned prawns manufactured as per the above method have shelf life as good as the untreated ones.

331. RAJENDRA BADONIA (M)

Canning of edible oysters. *Symposium on Coastal Aquaculture*, Cochin. 12th–18th January, 1980

Edible oyster (*Crassostrea cucullata*) was canned in different filling media viz, its own nector, brine and double refined vegetable oil, to study the effect of each on the flavour and general quality characteristics of the final product. A method was worked out to produce a canned product of appealing flavour from oysters after light smoking. The paper reports the result of these studies.

FREEZING

332. KRISHNA PILLAI (V) and LEKSHMY (A)

On some aspects of quality of cooked frozen prawns. *Indian J. Fish.*, 8 (2) 1961: 440-448

Prawn of more than 100 counts are generally pre-cooked before freezing and packing. A total bacterial count of

100,000-200,000 per gram muscle is suggested as an arbitrary limit for an acceptable quality of cooked frozen prawn in many countries. Bacterial counts on each batch of prawn were taken immediately after cooking, after cooling and packing and after freezing. Since most of the bacterial contamination of the cooked material takes place during the cooling time, the longer the interval, the greater was the contamination. The bacterial count is brought down to below 1000 organisms per gram as a result of cooking. But this figure increased up to 400,000 and above per gram during the course of 2½ hours of cooling in factory atmosphere. Incubation of the material at 55°C in sterile containers results in progressive reduction of the bacterial count.

333. LEKSHMI (A), GOVINDAN (T K), MATHEW (A) and PILLAI (V K)

Studies on frozen storage of prawn. *Indo-pacif. Fish. Coun. Occ. pap.* 63/2, 1962.

Headless prawns stored in ice were frozen after varying periods of storage and the physical, chemical and bacteriological characteristics of raw and thawed material and the drip obtained when the frozen material is thawed have been studied in relation to the quality of the frozen product. The characteristics of the drip are not of much use for determining the quality of the frozen product But the characteristics of the thawed muscle can give valuable information about initial freshness of the material that had been used for freezing which in turn determines the quality of the frozen product.

334. LEKSHMY (A), GOVINDAN (T K) and PILLAI (V K).

Storage characteristics of frozen prawns in relation to quality assessment. *Indian J. Fish.*, 9 (1), B 1962: 58-70.

Prawns (*Penaeus indicus*) in the headless condition were examined for physical, chemical and bacteriological characteristics in the fresh condition and frozen immediately. Prawns from the same lot were well iced and kept in a chill storage for 15 days. Samples were removed at intervals and frozen after the initial examination of quality of the raw material. The frozen blocks were tested chemically and bacteriologically immediately after freezing and analysis were conducted for a period of 10 months subsequently.

During storage of prawns in ice the moisture content of the prawn muscle showed steady increase. The bacterial count, TVN and TMA followed the same pattern of change. After an initial drop in these values for 4-6 days, there was a sudden rise and the values went on increasing thereafter. Water soluble nitrogen, non-protein nitrogen and amino nitrogen showed a gradual fall throughout the entire period of storage in ice. Materials kept longer in ice showed a higher moisture content after freezing. This observation may be useful as index for inspection of frozen fishery products. The bacterial load of frozen blocks showed progressive fall during the period of 300 days. The longer the period of ice storage of the raw material the lesser was the destruction of bacteria during freezing. There was no significant change in the TMA, TVN, non-protein nitrogen and water soluble nitrogen during storage.

335. LEKSHMY (A) and PILLAI (V K)

Faecal indicator organisms in frozen prawn products: Incidence and general distribution. *Fish. Technol.*, 1 (1) 1964: 48 - 56

A general survey carried out on frozen prawn products have shown that along with the standard plate count (SPC), the numbers of pathogenic organisms like *Escherichia coli*, *enterococci* and coagulase positive *staphylococci* have also to be taken into consideration for evaluation of the quality of these products. The distribution of bacteria varied from a minimum of 40,000 to a maximum of 72,00,000 organisams per gram for P & D, from 14,000 to 31,00,000 for headless and from 4,100 to 2,00,000 for cooked frozen prawn. The incidence of feacal indicator organisms like *E. Coli* and *Enteroccocci* as also *Staphylococci* in the products depends mostly on the conditions of preprocess preparation of the material. Among the three indicator organisms, *entrococci* seem to be more reliable as an index of faecal contamination as these undergo the least fluctuations during preparation and processing.

336. PILLAI (V K)

Studies on the use of Alginates in frozen fishery products. *Fish. Technol.*, 1 (2) : 1964 : 176-179.

Results of preliminary studies on the use of sodium alginate as a protective coating for fishery products have been discussed. A 2.5% solution of sodium alginate was mixed with calculated quantities of phosphate salts of sodium and calcium followed by addition of citric acid. The cleaned fish and prawns were given a dip in the above gel and immediately frozen at -40°F and stored at -10°F. The studies showed that alginate jelly is a very effective coating material for frozen fish and shell fish products. Its commercial application, however, depends on the cheapness of the treatment and the adaptability of the method to factory procedures.

337. MATHEN (Cyriac), CHOUDHURI (D R) and PILLAI (V K)

Use of different glazes in frozen oil sardines *Fish. Technol.*, 3 (1) 1966: 30-37.

The seasonal variations in the fat content of oil sardines (*Sardinella longiceps*), their frozen storage life at -18°C and treatment with various chemicals and glazing materials for extending the storage life were studied in detail. Changes in peroxide values, free fatty acids, moisture, drip and organoleptic characteristics during frozen storage were noted. It was observed that there is an inverse relatoinship between the oil content and the frozen storage life. The fish with oil contents varying from 10 33 to 42 43% (MFB) showed storage life from 5 to 2 months Dipping in hydroquinone solution prior to freezing or coating with agar agar after freezing extended the storage life of oil sardines.

338. PILLAI (V K)

On some factors controlling the quality of frozen and canned fishery products. *Seafood Export J.*, 1 (3), 1966, 17-18.

Besides freshness of the raw material many factors have to be taken care of at every stage of processing to obtain good finished fishery products. In this article, the author has listed some important points on simple control measures like frequent changing of the

glazing and reglazing water, chlorination of water used in the factory including that used for manufacture of ice, treatment of vessels and tables, use of detergents followed by chlorination etc. to prevent possible contamination in frozen material.

339. KAMASASTRI (P V) DOKE
(Shyam Narayanan) and
RAMANANDA RAO (D).

Some aspects of freezing and frozen storage of pomfrets. *Fish. Technol.*, 4 (2), 1967: 78–84.

Better frozen products can be obtained by freezing good quality pomfrets transported in insulated containers with sufficient quantity of ice. To enhance the keeping quality and prevent dehydration and discolouration of frozen products, a dip in BHA (0.005%) for 15 minutes and subsequent storage in polythene lined gunny bag at – 15°C to – 18°C are recommended. The products treated in the above manner can be stored well for over six months. Periodical glazing at an interval of 3 weeks also prevents dehydration to a greater extent.

340. MATHEN (Cyriac)

Phosphate treatment of frozen prawns: Screening of various phosphates for prevention of drip loss. *Fish. Technol.*, 5 (2), 1968: 104–112.

Various phosphates and their mixtures were screened for their efficiency of preventing drip loss in frozen prawns. The volume of dip solution was 60% of the weight of the material and dipping time was 2 minutes. The treated materials were drained for 3 minutes, frozen at -40°C and stored at 18°C. The effectiveness of the phosphates decreased in the following order: Sodiumtripolyphosphate - Sodium pyrophosphate – Sod. hexametaphosphate, –Sodium metaphosphate –Sodium dihydrogen phosphate, the last two being ineffective.

Even though thaw drip loss was reduced by the above treatment, the organoleptic quality of the thawed as well as cooked products was unsatisfactory, discolouration being the major defect. A solution of a mixture of 12% sodium tripolyphosphate and 8.6% sodium dihydrogen phosphate or 2% citric acid in water when used as dip prevented thaw drip loss, improved cooked yield and organoleptic quality without adversely affecting the biochemical characteristics. Commercial scale trials showed that the results are highly reproducible.

341. GOPALAKRISHNA IYER (T S),
CHOUDHURI (D R) and
PILLAI (V K).

Studies on technological problems associated with the processing of cooked frozen prawns: Preprocess storage conditions of raw material in relation to quality. *Fish. Technol.* 6 (1) 1969: 42–48.

The chemical and organoleptic properties of prawns held in ice for different periods prior to cooking and the changes after freezing and subsequent storage were studied with three different species of prawns viz. *Metapenaeus monoceros*, *Metapenaeus dobsoni* and *Parapeneopsis stylifera*. The optimum period for which the prawn can be kept under ideal conditions of icing prior to cooking has been worked out.

The maximum number of days permissible for keeping different forms of prawns (whole, HL and PD) in ice under ideal

conditions of icing to prepare cooked frozen prawns are P D : 5-6, HL 6-7 and whole 4-5 irrespective of species.

342. KAIMAL (P N R).

Freezing of oil sardines. *Indian Seafoods*, 7(2), 1969 : 21-24

Oil Sardine, (*Sardinella longiceps*) forms one of the most important marine fishery resources of India. The major difficulty encountered in preserving oil sardine in ice or in the frozen state is the phenomenon of "belley bursting". Investigations undertaken in CIFT on the causes of 'belly bursting' and measurse for its prevention, have shown that treatment of the fish in brine solution of specific concentration for a specified period greatly reduces the extent of belly bursting. On the basis of the findings of CIFT on the freezing characteristics of oil serdines, the method for freezing the fish has been summarised in the paper.

343. PERIGREEN (P A), GOVINDAN (T K) and PILLAI (V K).

Effective method for reducing belly-bursting in frozen oil-Sardines. *Fish. Technol.*, 6 (1), 1969: 55-58.

Sardines were dipped in different concentrations of NaCl for differenf lengths of time after which they were drained, packed in trays, glazing water added and frozen fo - 15 to - 20°C in contact plate freezer. The frozen blocks of sardines were then allowed to thaw at room temperature and the extent of belly bursting was noted as also salt absorption and organoleptic quality. The effect of size and fat content of sardines on belly-bursting phenomenon and storage characteristics of brine-treated sardines were studied.

A dip treatment in 15% sodium chloride solution for 30 mts prior to freezing was found to be effective in reducing belly bursting occurring during freezing and thawing of oil sardines.

344. MATHEN (Cyriac)

Phosphate treatment of frozen prawns. II-Frozen storage characteristis of prawn meat treated with polyphosphates. *Fish. Technol*, 7 (1), 1970 : 52-57.

The changes in physical, organoleptic and biochemical characteristics of prawn treated with alkaline and neutral solutions of polyphosphates during frozen storage have been studied. Data on changes in thawed and cooked yields, water extractable nitrogen, non-protein nitrogen, free alpha amino nitrogen, salt solubility, myosin and moisture in the muscle and loss of soluble nitrogenous contituents in thaw drip during frozen storage up to seven months are presented.

The salt solubility remained unchanged during storage in sample treated with neutral polyphosphate solutions and the organoleptic quality was superior to control sample. Dip treatment with neutralised solutions of tripolyphosphate not only maintains correct drained weight and improves cooked yield during prolonged frozen storage but also protects the frozen product from denaturation as measured by the salt solubility of the proteins.

345. MATHEN (Cyriac)

Simple and cheap method for minimising thawing and cooking losses from prawns. *Fish. Technol.*, 7 (1), 1970: 97-98.

A dip treatment for minimising thawing and cooking losses from prawns is suggested. Experiments with peeled and

deveined prawns using varying concentrations and volumes of soultions of STPP+PDP were carried out to determine the optimum concentration and volume of the solution to be employed.

The results show that 40 ml of 16% solution is the optimum required per 450g. With this, the thawed yield was cent percent and cooked yield 14% higher than that of untreated. The advantages of the method are that the excess weight of prawns usually added to compensate for thawing losses (nearly 10%) is saved and the water extractable nitrogen does not become insoluble.

346. MATHEN (Cyriac), GOPALAKRISHNA IYER (T S) and CHOUDHURI (D R)

Comparative efficiency of different glazes for frozen prawns of commerce. *Fish. Technol.*, 7 (1), 1970: 91-93.

Studies carried out on the effect of different glazes on the biochemical, bacteriological and organoleptic quality of prawns during frozen storage are reported. In unglazed samples the colour and texture deteriorated within two months while the sample glazed with salt-sugar was acceptable even after eight months.

For short term storage (less than 2 months) of prawn, freezing without glaze is preferable while for long storage glazing is essential. Glazing with a salt-sugar solution is superior to ordinary water glaze in maintaining overall quality.

347. MATHEN (Cyriac) and PILLAI (V K)

Prevention of weight losses in sea foods with polyphosphates. Bull. International Institute of Refrigeration. Leningard. 1971: 151-257.

This paper covers a general appraisal of the magnitute of the problem of weight loss due to thaw and cook drip formation in important sea foods and reviews the progress made in minimising these losses.

Sodium tripolyphoshate is the widely used antidrop chemical. The efficency of varying concentrations of different phosphates to prevent drip loss was assessed when used as a dip prior to freezing. The result shows that the optimum effective concentration is 12% for the various phoshpates. Besides minimising thaw drip loss, the treatment helps to retain the size grade of the raw material unchanged during freezing and thawing.

348. VASANTH SHENOY (A) and PILLAI (V K)

Freezing characteristics of tropical fishes : I Indian oil-sardine. *Fish. Technol.*, 8 (1), 1971: 37-41.

The influence of pre-freezing ice storage periods on the biochemical and organoleptic qualities of Indian oil-sardines (*Sardinella longiceps*) in indivldual quick frozen (IQF) and block frozen (BF) forms and frozen storage at -12°C and -23°C was studied.

The shelf life of the sardines varied between 24 and 2 weeks for samples iced for 0 to 5 days prior to freezing. The deterioration in quality was accompanied by considerable increase in the peroxide value (PV) and free fatty acid (FFA) and decrease in salt extractability of the proteins. These changes were more rapid at -12°C than at -23°C. BF sardines appeared to be better than IQF samples with respect to biochemical quality although the differences in overall organoleptic quality were not significant.

349. GOVINDAN (T K)

Research on freezing preservation of fish in India A review. Indian Fd. *Packer*, 26 (1). 1972: 52-59.

Even though considerable amount of work has been reported on freezing of fish other than the foreign exchange earners, viz. prawns and froglegs, our industry is conspicuous in not applying any of this information in their trade, although more than 50% of the installed processing capacity goes idle due to want of sufficent quantities of prawns. Application of this technique of preservation is a must for our country in order that this cheap source of animal protein be made available to a large sector of our protein starved population over longer periods in the year. A brief review of research work on solving the problems like improving the hygienic, nutritional and organoleptic qualities of the frozen products and evolving suitable methods for preservation by freezing the commercial food fishes is presented in the paper.

350. MATHEN (Cyriac), THOMAS (Francis) and PILLAI (V K)

Prevention of cook drip loss from shrimp meat. *Seafood Export J.*, 4 (12), 1972 : 9.

The authors report a method whereby the yield of cooked prawns could be raised to 73-75%. The method involved is mixing the shrimp meat prior to cooking with an aqueous solution of 12% sodium tripolyphosphate, 4% potassium dihydrogen phosphate and 16% sodium chloride at the rate of 90 ml solution per kilogram of shrimp meat.

351 VASANTHA SHENOY (A) and JAMES (M Arul)

Freezing characteristics of tropical fishes: II-Tilapia (*Tilapia mosambica*). *Fish Technol*, 9 (1), 1972: 34-41.

The paper reports the summary of work done on ice and frozen storage characteristics of *Tilapia mosambica*, an important species used in fish farming.

Tilapia from fresh water and brackish water sources behaved differently during iced and frozen storage. The former showed an ice storage shelf life of about 13 days while the latter showed signs of spoilage beyond 10 days. In their respective freezing characteristics, the samples from the two sources exhibited far more significant variations.

The fresh water type iced for 13 days preserved well for over 24 weeks when frozen and kept at a temperature of -18°C, while the brackish water variety held in ice for 10 days and subsequently frozen gave a shelf life of only 8 weeks under similar conditions.

352. GEORGE (Chinnamma)

Technological aspects of preservation and processing of edible shell fishes. IV - Comparative efficiency of different glazes in the preservation of frozen crab meat. *Fish. Technol.*, 10 (2) 1973: 166-167.

The comparative efficiency of different glazes in improving the quality of frozen crab meat (*Scylla serrata*) was studied and the results are presented in this paper.

The results clearly indicate that of all the glazes studied, ascorbic citric acid

mixture was the best for extending shelf-life, preventing discolouration and minimising drip loss.

353. GEORGE (Chinnamma)

Quality loss in prawns due to double freezing. *Fish. Technol.*, 10(2), 1973: 170-172.

The extent of quality loss in prawns during double freezing was studied on a laboratory scale and the results presented. Some changes are brought about by refreezing and when compared to the quality loss in icing, they are less. The major quality defects are high drip loss and high rate of blackening.

354. GEORGE (Chinnamma)

Technological aspect of preservation and processing of edible shell fishes: III-Factors influencing the keeping quality of crab *Scylla serrata*) during freezing and frozen storage. *Fish. Technol.*, 10 (1), 1973: 15-20.

The possible factors leading to the loss of flavour and general quality of crab during freezing and frozen storage have been studied. The pre-process ice storage condition of the raw material was found to be one such important factor. While the fresh frozen crab meat remained in good organoleptic condition for about 51 weeks at-23°C, 7 days iced material held frozen was found to have a shelf life of only about 21 weeks. The fall in myofibrilar protein noted during frozen storage together with the loss of myosin ATP-ase activity correlated well with the loss of organoleptic qualities.

355. MATHEN (Cyriac)

Bacterial aspects of quality of phosphate treated frozen prawns. *Fish Technol.*, 10(2), 1973: 168-169

The paper gives an account of the results on the influence of phosphate treatment on the bacterial quality of raw frozen shrimp meat. Reports on the effect of phosphate treatment on the bacterial quality of the finished product are rare. The phosphate treatment does not add to bacterial counts of treated and frozen prawns if the solution is prepared in water chlorinated to a level of 10 ppm and usual sanitary precautions are taken during treatment, freezing and storage.

356. RADHAKRISHNAN (A G)
SOLANKI (K K) and
VENKATARAMAN (R).

preliminery studies on freezing characteristics of Bombay duck (*Harpodon nehereus*). *Fish. Technol.*, 10 (2), 1973: 124-130

Fresh Bombay duck (*Harpodon nehereus*) can be quick frozen at -40°C and stored at -10°C for about 3 months in a very fair and acceptable condition. The maximum drip loss observed was about 24%. Rapid decrease in the extractable protein nitrogen of the fish muscle was noted during frozen storage.

357. GEORGE (Chinnamma)

Technological aspects of preservation and processing of edible shell fishes : V- Cold storage changes in mussels (*Mytilus edulis*) and clams (*Villoritis sp.*) *Fish. Technol.*, 11 (1), 1974 : 22-27

The changes in chemical, bacteriological organoleptic qualities of mussels and clams during freezing and subsequent frozen storage have been studied in

relation to the holding time in ice prior to freezing and the shelf life of the product determined.

In the case of mussels the fresh frozen material remained in acceptable condition for 40 weeks and 8 days iced material only for 15 weeks, while the fresh frozen clams remained in acceptable condition for only 35 weeks and the shelf life of 8 days iced material was only 4 weeks.

358 GOPALAKRISHNA IYER (T S), JOSEHP (A C) and MATHEN (Cyriac)

Freezing of frog legs. *Seafood Export J*, 6 (11). 1974 : 19-21.

A method to prepare salmonella - free frozen frog legs is outlined. It consists of paralysing the frogs by dipping in 10% solution of common salt for 10 minutes, dipping the severed legs with the skin in 3% brine containing 200 ppm available chlorine dipping the deskinned legs in 5% brine containing 500 ppm available chlorine for 15 minutes. This is followed by washing three times in water chlorinated to a level of 200 ppm, the last washing serving as a dip for 10 minutes. They are then wrapped individually, frozen at-40°C and stored at - 20°C.

359. PERIGREEN (P A) and NAIR (M R)

Technological aspects of chilling and freezing of tropic fish.

Souvenir International Seminar on Refrigeration application for fish, fruits and vegetables in the Far East Region, Durgapur. "14-24" Jan. 1974.

Insufficient knowledge of the technological problems peculiar to the tropical varieties of fish like sardine, mackerel, tuna and pomfret is largely responsible for the apparent inhibition by the processors in utilizing these fishes into frozen products. It was shown that accelerated spoilage of black pomfrets is due to higher percentage of red muscle and adipose fat content in the fish. Oil sardine (fat content 19% DWB) when stored in ice showed rapid increase in peroxide value and free fatty acid and become inedible within 5 days of storage. Considerable expansion of storage life of oil sardines was obtained by dipping the fish in 0.05 to 0.5% solution of hydroquinone prior to freezing or coating the frozen blocks with 1 percent agar agar. Evaluation of the effect of short term fluctuation in temperature on the quality variations of frozen fish cargo have brought out that the frozen P D prawns stored at -23°C when subjected to intermittant storage at-12°C for 1 week to 2 weeks underwent noticeable deterioration in quality, the organoleptic criteria corroborrating well with protein extractibility and thaw dilp characteristics.

360 RAO (C V N) and MATHEN (Cyriac)

Thawing frozen prawns electrically. *Indian Fd. Packer*, 23 (6), 1974 : 26-30.

Voltage conditions have been standardised for electrical resistance thawing of headless shell on, cooked and peeled and deveined (2.25 Kg) frozen prawn blocks of thickness 45 to 60 mm. The thawing periods are reduced by 40 to 50 percent of those by conventional method of thawing in running water. Temperatures were recorded continuously at centre and surfaces of the frozen

blocks to ensure that no overheating took place. Heat input by the electrodes was kept st about 1/3 to 1/2 of the enthalpy of block at 15°C measured calorimetrically. The electrically thawed material compares favourably with the water thawed correct in physical, organoleptic and bacteriolgical evaluation.

361. GEORGE (Chinnamma)

Biochemical differences between the red and white meat of tuna and changes in quality during freezing and storoge. *Fish Technol.*, 12 (1), 1975 : 70-74.

The differences between the white and red (dark) meat of tuna (*Katsuwonus pelamis*) in chemical, physical and organoleptic aspects and the rate and pattern of spoilage during freezing and subsequent storage are discussed.

In all indices studied, distinct difference is seen between the white and red meat as well as in the head, middle and tail portions of the same fish. The characteristic colour of tuna meat is due to the presence of haemoglobin and myoglobin the concentrations of which are about 5 times more in red meat than in white meat. The shelf life of the frozen material varies with the type of the pack, that is, whole fish, chunks, fillets, the last being adversely affected during frozen storage.

362. GEORGE (Chinnamma) and NAIR (M R)

Technological aspects of preservation and processing of edible shellfish. proc. Handling, Processing and Marketing of Tropical Fish. TPI. London, 1976: 413-416.

The influence of pre-process ice storage on the nutritive value and chemical constituents of cooked frozen mussel (*Mytilus edulis*) and crab (*Scylla serrata*) available on the west coast of India, has been studied. Large scale trials carried out on the freezing of crab showed that the optimum cooking time was 16 minutes in boiling brine. The yield of body meat was 16 to 18% and that of claw meat approximatety 20%. The thawing loss of frozen body meat was 6 to 12% and that of claw meat 6 to 8%. Studies on the storage life of frozen claw meat, both raw and cooked, indicated that the cooked product kept better than the raw frozen material, the frozen raw claw meat blackened during storage. In the case of mussel meat the optimum cooking time was 15 minutes and the yield 14 to 16%. The thawing loss in the product was 2 to 4%, shelf life was judged by chemical and organoleptic methods. The maximum frozen storage life was observed in pre-iced and cooked crab meat.

363. KANDORAN (M K)

Technological aspects of freezing. *Seafood Export J.* 8(9). 1976 : 21-30.

This is an article on the technological aspects of freezing which may be useful to the technical personnel engaged for the production of high quality frozen fish and shell fish in our country.

Freezing means removal of heat from a body During freezing protein - water gel is completely altered because the water separates out as pure ice, leaving the proteins more or less dry. Quick freezing means generally that the temperature of every part of the product falls below the zone of 0°C to - 5°C as rapidly as possible and within a certain time limit. Freezing process is complete for practical purposes when most of the freezable water of the product has been converted into ice which coincides with

most products with the temperature at the thermal centre becoming colder than –10°C (14°F) Different types of freezer like sharp freezer. air blast freezer, contact plate freezer, vertical plate freezer, Immersion freezer liquid freon freezer, liquid nitrogen freezer etc. are in vogue.

364. VASANTH SHENOY (A)

Freezing characteristics of tropical fishes III–Spotted seer (*Scomberomorus guttatus*). Fish. Technol. 13(2), 1976: 105–110.

Skin-on fillets of spotted seer were frozen individualy with different prefreezing ice storage periods and stored at –23°C. and –10°C. The frozen storage shelf life was evaluated with respect to holding time in ice prior to freezing by examining the extent of oxidative rancidity, protein denaturation, organoleptic changes etc. Fillets with pre-freezing ice storage periods of 0, 3, 5 and 7 days had frozen storage shelf life of 32, 24, 20 and 16 weeks respectively at –23°C, The fillets stored in ice for more than 7 days are unsuitable for further processing. Storage temperature greatly affectad keeping quality of frozen fillets. Freshly frozen fillets stored at – 10°C became unpalatable at 16–20 weeks as compared to 28–32 weeks for the fillets stored at – 23°C.

365. JOSEPH (Jose) GIRIJA VARMA (P R) and VENKATARAMAN (R)

Iced and frozen storage of squid (*Loligo Sp.*) Fish. Technol., 14 (1), 1977 : 13 – 20.

This paper deals with the changes occurring in squid during iced and frozen storages in relation to the organoleptic qualities.

Squid can be kept in ice in an acceptable condition for a maximum period of 2 days. Frozen squid can be stored for a maximum period of 15 weeks at–18°C. which can be extended upto 19 weeks by suitable treatment.

366. DEVADASAN (K), VARMA (PRG) and VENKATARAMAN (R)

Studies on frozen storage characteristics of fillets from six species of fresh water fishes. *Fish. Technol.*, 15 (1), 1978: 1 6.

The paper reports results of a detailed study on frozen storage characteristics of fillets from six major species of fresh water fishes namely, *Labeo rohite, Catla Cattla, Cirrhina mrigala. Labeo calbosu, Mystus seenghala and Wailago attu.*

The biochemical, bacteriolagical and organoleptic changes in the frozen fillets during storge at 18°C have been followed systematically. Compared to the two species of fresh water cat fishes, the four species of carps studied had slightly better storage life. From the organoleptic point of view fillets of *Cirrhina mrigala* had the best shelf life.

367. MATHEN (Cyriac), MATHEW (Annamma), GIRIJA VARMA (P R) and THOMAS (Francis)

Method for the preparation of cooked–peeled -frozen prawns. Fish. Technol., 16 (1), 1979 : 33-35.

The paper reports results of investigations carried out with a view tc establishing the difference in TPC at 30 and 37°C and working out procedure for the preparation of this item with as low a TPC at 30°C as possible.

The specified temperature of incubation for TPC in our country is 37°C. The

effect of incubation at 30 and 37°C on TPC was studied. It is seen that the count is higher on incubation at 30°C. A method for production of cooked-peeled-frozen prawns conforming to the specification for TPC at 30°C is standardised and is reported. It consists of recooking the cooked-peeled prawns followed by packing and freezing without further contamination. The method minimises batch to batch or sample to sample variation in TPC.

368. PERIGREEN (P A)

Some aspects of freezing fish and fishery products. *Industrial Fish. Ass,, University of Cochin*, Cochin, 1979: 10–12.

The application of freezing preservation and cold storage to fish and fishery products facilitates uniform distribution of fish within the country during all seasons and fetches good returns to the fishermen. Contact plate freezing and tunnel freezing are employed for freezing of sardine and mackerel. The frozen shelf-life of oil sardine is dependent on the fat content and there is an inverse relationship between the oil content and frozen storage life. Although, many different types of glaze have been introduced, ice is still the only glaze of considerable commercial importance. The picked meat can be preserved and stored for sufficiently long periods by freezing. The fresh picked meat or frozen and thawed picked meat is used as base material for the production of fish hydrolysates, fish protein concentrate or other processed and ready to cook special products like fish cutlets, fish balls, fish fingers. fish sausages, etc. The technology for the production of these speciality products from fish are now available and hence the products are sure to find a prominent place among the processed food products available in our markets.

369. JOSEPH (Jose), PERIGREEN (P A), GEORGE (Chinnamma) and GOVINDAN (T K)

Iced and frozen storage characteristics of cultured *Chanos chanos* (FORSKAL). *Fish Technol*, 17 (1), 1980: 21 - 25

Freshly harvested milk fish (*Chanos chanos*) were stored in crushed ice and their storage life was estimated by following biochemical, bacteriological and organoleptic changes occuring during storage. Samples of the fish were withdrawn at various intervals of storage, quick forzen, glazed and held in frozen storage at -18°C. Shelf life in frozen storage was determined in relation to period of ice storage prior to freezing by determining biochemical and organoleptic characteristics upto 30 weeks.

370. PERIGREEN (P A) and JOSEPH (Jose)

Freezing and cold storage of cat fish fillets. *Fish. Technol.*, 17(1), 1980 : 31 - 34.

The freezing and cold storage changes occurring in skinless fillets of cat fish and the effect of packaging on the quality of forzen fillets during storage at -18°C were studied in detail. Fillets frozen as glazed (water) blocks and packed in ploythene lined waxed cartons showed a shelf life of 27 weeks.

371. JOSEPH (Jose) GIRIJA VARMA (P R) and VENKATARAMAN (R)

Iced and frozen storage of squid (Loligo Sp.) *Fish. Technol.*, 14 (1), 1977 : 13–20.

The paper deals with the changes occurring in squid during iced, frozen and storage in relation to the organoleptic qualities.

Squid can be kept in ice in an acceptable condition for a maximum period of 2 days. Frozen squid can be stored for a maximum period of 15 weeks at –18°C which can be extended upto 19 weeks by suitable treatment.

372. SIBSANKAR GUPTA, SUBRATA BASU, IMAM KHASIM (D) and PANDURANGARAO (C C)

Studies on the preservation of cultured *Chanos chanos* by icing and freezing. ***Symposium on Coastal Aquaculture***, Cochin, India. 12th – 18th January 1980.

Brackish water fish farming, though practised traditionally since long, has been taken up for scientific study only in recent years. With the avilability of technical know-how for culturing of the milkfish *Chanos chanos*, efforts are under way in various States to produce it in larger quantities. The present work was undertaken to study the amenability of this variety of fish to icing and freezing and to determine its shelf life.

Cultured *Chanos chanos*, immediately after harvest, were packed with an equal quantity of ice in thermocole insulated plywood boxes and the ice was replenished daily. The temperature of the fish was maintained between 0-1°C. The fish were periodically examined for organoleptic, biochemical and bacteriological quality. The fish were found to remain acceptable upto 19 days.

Amenability of fresh, one-day ice stored, two days ice stored and three days ice stored *Chanos* chanos to frozen storage was studied. Frozen fish was stored at –18°C. and the quality of the fish was studied periodically by organoleptic, biochemical and bacteriological tests. All the frozen *Chanos chanos* were found to remain in good condition even after one year.

IRRADIATION

373. GOVINDAN (T K)

Irradiation and its scope in fish preservation, ***Seafood Export J.***,1(5), 1969: 7–10.

The principle involved in preservation of food material with nuclear energy is to allow ionising radiations to pass through them when the microorganisms present in them are partially or wholly destroyed depending upon the degree of exposure. The sources of radiations generally employed are radio active elements like Co-60, Cs-137 and Sr-90. X-rays and high speed electrons are also useful for the purpose. Fish and other sea foods have been found to respond quite well to radiation treatment. The application and the scope of irradiation in fish preservation is discussed in detail.

374. VENKATARAMAN (R), KANDORAN (M K), SOLANKI (K K) and RAJE (C R)

Preliminary studies on the effect of irradiation as means of preservation of fish and shell fish. ***Fish Technol.***, 6(2), 1969 153–163.

The study on preservation of commercially important fish and shell fish by irradiation was conducted with a view to finding out how far this method could be adopted either alone or in combination with similar processes in

our country. As a pilot study, the investigation was carried out on prawns, Bombay duck and silver pomfret. Irradiated samples had extended storage life compared to their respective controls even though yellowish or brownish discolouration occurred in the former. Brine treatment prior to irradiation retarded the rate of discolouration and extended the storage life of irradiated fish.

375. GOVINDAN (T K)

Nuclear energy for food preservation. *Seafood Export* J., 3(6), 1971: 13-17.

Irradiation offers a welcome method of preservation of food materials, especially for developing countries like ours, whose food resources are comparatively underexploited and certain amount of wastage of the already exploited food materials also occurs due to insufficiency of proper facilities for preservation, storage and distribution. However, as excessive dosage of radiation causes undesirable organoleptic changes as well as probable ill effects on human health. It is also desirable to experimentally arrive at the dosage levels so that unnecessary excess dosages could be avoided,

BY PRODUCTS

376. KAMASASTRI (P V) and PRABHU (P V)

Preparation of chitin and glucosamine from prawn shell waste. J. Sci,. & Ind. *Res*., 20 (12) D,1961: 466.

A process is reported for the recovery of chitin from prawn shellwaste and its conversion to glucosamine hydrochloride. The yield of glucosamine hydrochloride obtained was about 10 per cent on the basis of weight of the shell waste. The product analysed as nitrogen content 6.35%, ash content negligible, m. p. 190°C (decomp) mol. wt. 103, dissociation in 1% solution, 100 percent. These data indicate that the product is pure.

377. KAMASASTRI (P V) and RAMANANDA RAO (D)

Studies on Indian fish meals:

Part I. Chemical composition and storage characteristics' of fish meals prepared from different types of fishes. *Indian* J. *Fish*., 9 (2) B, 1962: 108-117.

Fish meal is highly valued in cattle and poultry nutrition for its content of easily digestable proteins, vitamins and minerals. The behaviour of the constituents of different types of fish meals prepared under identical condition during the storage was studied in detail. The chemical composition such as moisture content, protein, fat, ash, acid insolubles, calcium as CaO, phosphorus as P_2O_5, non-protein nitrogen, total volatile nitrogen and aminonitrogen were determined for fish meal prepared out of caranx, jew fish. sardine and mackerel. The changes in the nitrogenous fraction of the fish meal and fat during storage period 1 to 8 months were tested periodically.

378. KAMASASTRI (P V) and PRABHU (P V)

Proteins from prawn shell waste. *Res. & Ind.* 8 (2),1963 : 98 - 99

A method for the preparation of high quality protein from prawn shell waste

is described. The yield of the protein from prawn shell waste is 5–6 percent and its pepsin digestibility is 97–98 percent.

379. RAMANANDA RAO (D) and KAMASASTRI (P V)

Utilization of waste materials in the frog leg processing industry. *Indian J. Fish.*, 10 1, (B) 1963: 4 - 7.

Utilization of waste materials from the processing of frog leg is of immense value to compensate the processing expenses to a certain extent. With this object in view the waste materials which constitute about 65% of the total weight of the raw materials were processed into meal and oil and their chemical compositions were studied.

They yield of oil and meal varied from 6 to 8% and 12 to 14% respectively. The press cake dried at law temperature produced good quality meal with little oxidation in the fat component of the meal. The frog oil prepared did not undergo any change when stored for one year in sealed containers.

380. VENKATARAMAN (R) and VASUDEVA PRABHU (P)

Scope for dovelopment of shark skin leather industry. Tanner's Conference, Rajkot, 1964.

It is estimated that a total of 2 million sq. ft. of skin could be collected annuaally from the various varieties and sizes of sharks. The paper describes the flaying and processing of shark skin.

Given proper attention at various stages of production of skin, its collection and processing, there is immense scope for its development as a cottage industry based on shark skin processing.

381. NEELAKANDA KAIMAL (M N) and SESHAGIRI RAO (V)

Cholestrol from prawn head waste. *Fish. Technol.*, 2 (2), 1965: 198–199.

A process is described for the isolation of cholesterol from the fat obtained from prawn head waste. Petroleum ether extracted about 6% of fat from prawn head waste with less of pigments and the extract was decolourised by adding 1% activated carbon and kept overnight. It was then filtered and petroleum ether was removed by distillation. Of the unsaponifiable matter about 62% is cholestrol which was futher purified by bromination.

382. RAMANANDA RAO (D), KAMASASTRI (P V) and BOSE (A N)

Effects of different types of drying on the nutritive values of proteins in the fishmeals. *Fish. Technol.*, 2 (2), 1965 : 200–204.

A comparative study on the effect of different types of drying on the nutritive value of the proteins in the different fishmeals was made.

The mode of drying has little effect on the nutritive value of the meal is revealed by the chemical indices of available lysine and pepsin digestibility, provided enough precautions were taken to avoid scorching during drying process. Sun dried meals are found to be no way inferior to the meals prepared by hot-air, steam or vaccum drying.

383. JAMES (M Arul)

Ensiled product from fish by microbial fermentation. *Fish. Technol.*, 3 (1), 1966 : 38-43.

Jew fish (*Pseudosciaena sp.*) and Silver bellies (*Leiognathus sp.*) were subjected to the action of Lactobascillus plautarum, an active homofermentor after cooking for 20 min. and cooled to room temperature.

Fish ensilage prepared from jew fish and silver bellies indicated that they are good source of proteins, minerals and vitamins. Storage studies for one year indicated that the material was in good condition. The results indicate that fish enslage with its high nutritive values can be used to suppliment poultry and cattle feeds.

384. RAMANANDA RAO (D)

Studies on 'Doma' : Quality of the doma meal from fresh fish to that of room temperature spoiled ones. *Indo Pacif. Fish. Coun.*, 1966.

The influence of storage of raw fish (dhoma) for periods of 0, 8, 10 and 24 hours after landing at 28°C+2°C on the chemical quality of meal prepared by wet reduction process was studied.

The meals prepared from slightly spoiled material showed slightly better digestibility while lysine value, methionine and protein quality index showed a decrease and the gross energy values did not alter much. The unsaturation of the fat remained unaltered, while acid value and thiobarbituric acid number showed an increase for the meals prepared from spoiled material.

385. VENKATARAMAN (R)

Urgent need for the development of the shark skin leather industry. *Symposium on Tanners get-together* Madras, 1966.

The paper describes the techniques for tanning shark skin into good quality leather.

386. KAIMAL (M N N) and MADHAVAN (P).

Utilisation of sardine oil for industrial purposes: I-Factice for use as a filler in rubber compounding. *Res. & Ind.*, 12 (4), 1967: 251-252.

Factice has been used from early days in rubber industry as a filler which functions as an extender and aid for extrusion. The possibility of using sardine oil as a raw material for the preparation of dark factice for use as a filler in rubber compounding has been studied.

It was found that a product resembling commercial factice could be prepared by treating sardine oil at 180-200°C with 20 percent by weight of elemental sulphur.

387. KAMDAR (L D), KANDORAN (M K) and VENKATARAMAN (R)

Studies on shark liver oil and its residue. *Fish. Technol.*, 4 (1), 1967 : 21-27.

The seasonal variation of moisture contents and Vitamin A potency of shaik liver oil, was studied in detail.

The concentration of moisture and oil in shark liver was found to be inversely proportional to each other, maximum moisture and minimum oil contents were found during the summer. Month-wise fluctuation was noted in the case of Vitamin A potency of oil. It was also observed that with increase in oil content, Vitamin A potency decreased. Defatted liver residue was found to be rich in protein and Vitamin B contents and it can be used as a valuable blend with fish meal. The liver residue which is being wasted at present can thus be profitably utilised.

388. VENUGOPALAN (V) and GOVINDAN (T K).

Utilisation of trash fish: I – Preparation of fish flake, *Fish. Technol.*, 4 (1), 1967: 35- 43.

The paper deals with the investigations carried out on the preparation of odourless fish-starch flakes using partially deodourised trash fish meat and different sources of starch like corn, as tapioca, maida agd black gram.

It has been found that the products using corn and tapioca are better compared to those prepared using the other two starches, the product from corn being the best. The product has a protein content of about 20% and has been found to have shelf life of 4 months at 37°C.

389. ISMAIL (P K), MADHAVAN (P) and PILLAI (V K)

Studies on the preparation of fish proteinconcentrate. *Fish Technol.*, 5 (1), 1968: 53-59.

The paper deals with the method of preparation of an edible fish protein concentrate from cheap miscellaneous fish. The method consists in cooking the fish with 0.5% glacial acetic and extracting batch-wise, using ethyl alcohol followed by an azeotropic mixture of hexane and alcohol (B. P. 58°-68°C). The product is finally vacuum dried during which the residual solvent is also removed. A comparison has been made of the fish flour prepared from fish muscle alone, dressed fish mixed dressed fish and from whole fish.

The concentrate prepared by this method contains 85% protein of which 96% is pepsin digestible. The product is practically odourless and almost white in colour.

390. KAIMAL (M N N), GOPALAKRISHNA PILLAI (A G) and MADHAVAN (P)

Utilisation of sardine oil for industrial purposes : II – Surface coating material from sardine oil. *Res & Ind.*, 13 (1), 1968 : 24-26.

The oil sardine (*Sardinella longiceps*) is a rich source of oil, at the current level of catch being about 600 tonnes per annum. The main impediment for the commercial utilisation of sardine oil is its objectionable odour. The possibility of preparing surface coating materials from the oil has been investigated.

It has been found that the stearine separate oil on heating at 200°C in presence of cobalt oxide catalyst (1% on the weight of oil) for 2 hours resembled double boiled linseed oil in

its drying characteristics, in addition to the objectionable odour getting removed. The paint formulations prepared using this oil conformed to the Indian Standard Specifications for ready mixed paints.

391. MADHAVN (P) and KAIMAL (M N N)

Utilisation of sardine oil. *Paintindia*, 18 (4) 1968 : 50–53.

Extraction of sardine oil in pure form by improved methods and conversion of the oil into useful industrial products seem to be the major needs of the industry. Details of the traditional methods and the improved methods of extraction of oil from sardine, their industrial utilisations such as manufacture of factice, surface coating materials, printing ink and additive to lubricating oil are discussed,

392. MADHAVAN (P)

Prospects of fish meal manufacture in India. *Seafood Export. J.*, 1 (1), 1969: 27–31.

In order to assist the rapidly developing fish meal industry in the country, the ISI is preparing specification for fish meal as livestock feed which is expected to help in exercising proper quality control on the product. It has been observed that fish meal prepared from fish by the wet reduction process is superior in several respects to that prepared from sun dried fish. Experiments were carried out at the CIFT on the manufacture of fish meal from different kinds of commercially available fish. The percentage yield and chemical composition of some of them are given. Canning and freezing having assumed major importance in the fish processing industry, tons of waste products comprising mainly the head and shell of prawns are now available for fish meal manufacture.

393. VENKATARAMAN (R)

Fishery byproducts and their utilisation. *Indian Farming*, 19 (9), 1969 : 99–100.

The author has presented a discussion on the fishery byproducts and their utilisation. The chief protein rich by product of the fishery is fish meal, which is normally produced from so-called 'scrap fish', fish offal, oily fish like oil sardine and shell fish wastes. Fish meal is an excellent animal and poultry feed. Fish body oil is obtained as a byproduct in the wet reduction process of oil sardine and similar varities of oily fishes. The oil is in great demand for the leather tanning industry. Excellent fish glue can be manufactured from the skins of fish containing large amounts of collagen. Shark skin is another valuable byproduct, which is at present going virtually as a waste. The complete process of flaying, curing and processing of the skin has been perfected. Fish scales are a source of useful by products. Chitin, a polymerised acetyl glucosamine is present in 16 to 22% concentration in shells of crustacea such as prawns, crabs and lobsters. Chitin might form a useful alternative to cellulose for making adhesives, varnishes, wrapping materials, sausage casing etc.

394. VENUGOPALAN (V) and JAMES (M Arul)

Utilisation of trash fish. II-Studies on preparation of fish soup-mix. *Fish. Technol.*, 6 (2), 1969: 148–152

The paper deals with the investigations

carried out on the preparation of fish soup mix using partially deodourised trash fish meat. Mixed trash fishes comprising of kilimeen (*Synagris sp.*) jew fish (*Otolithes sp.*) and silver bellies (*Leiognathus sp.*) were dressed, cooked and the meat was separated and deodourised. The meat was blended with equal amount of water. The ingredients were fried to brownish colour and added to the homogenised fish meat and salt. They were mixed well, boiled for 5 minutes, poured in aluminium trays in thin layers and dried at 70°C in a tunnel dryer for 5–6 hours. The dried material was powdered followed by addition of nutritive agents, sweetener, emulsifiers and preservatives.

The product contained about 25% protein and had a storage life of 4 months at ambient temperatures (28-31° C.) Soup could be prepared by boiling 5% suspension of the powder for 1 to 2 mts.

395. ISMAIL (P K) and MADHAVAN (P)

Note on liquid fertilizer from shrimp and fish wastes. *Fish. Technol.*' 7(2) 1970: 216-217.

A simple method of preparation of liquid fertilizer of two different NPK ratios suitable for common crops of Kerala like coconut, arecanut, ginger, tapioca, pepper and vegetable is discussed. The prawn waste was mixed in appropriate proportions with fish waste and an equal amount of water by weight. The pH of the slurry was adjusted to 2 0 by the addition of Con. HCl and kept for five days. It was filtered and the residue was digested with calculated amount of NaOH or KOH and filtered. The filtrates from the two steps can be conveniently mixed before use. The process is characterised by the simplicity of the procedure and the low cost of the raw materials involved The method is equally applicable for the preparation of liquid fertilizer from shrimp waste and fish waste or combination of both.

396. VENUGOPALAN (V), CHAKRABORTY (P K), JAMES (M Arul), and GOVINDAN (T K)

Protein from blanch liquor. *Fish. Technol.*, 7 (2), 1970 : 143-145.

A process is described for isolation of edible protein from blanch liquor which is discarded as waste at present from prawn canning factories. The protein isolated is colourless and edourless and is comparable to fish protein concentrate in amino acid composition.

397. RADHAKRISHNAN (A G) and PRABHU (P V)

Chitosan from prawn waste. *Res & Ind.*, 16 (4), 1971 : 265–267.

A method has been developed for the preservation of prawn waste (shell and head) and the preparation of chitin and chitosan.

Preservation of prawn shell waste for a period of one week is achieved by keeping it under 1–2% sodium hydroxide solution. The main steps in the isolation of chitin are removal of proteins by boiling with aqueous sodium hydroxide solution (5%), immersing over-night in hydrogen peroxide solution (0.5%) and demineralisation with dilute hydrochloric acid. Chitosan is obtained from chitin by deacetylation with strong aqueous or alcoholic alkali solution.

398. GOVINDAN (T K)

Oil sardine : An energetic food and potent industrial raw material. *Seafood Export* J. 4 (8), 1972: 37–41.

The oil sardine scientifically known as *Sardinella longiceps* stands unique among the Indian fishes for reasons more than one viz. the quantity landed, food value and vast potentialities as an industrial raw material. Oil sardines accounts for 24.6% of the total marine fish landings in India on the average. The salient features of the oil sardine, its uses as a potent industrial raw material along with methods of its preservation by freezing and canning and the method of extraction of the oil are discussed in detail.

399. GOVINDAN (T K)

Convenience : Foods from fish. *Seafood Export*, J., 4 (1), 1972. 157-160.

Quite a number of products can be prepared and preserved by canning or other methods from different varieties of fish available in our country.

Development of products like fish flakes, fish soup powder, sausage etc. can effectively utilize cheaper varieties of fish ensuring better returns to the fishermen for their catches and thereby improving their economic condition.

400. GOPALAKRISHNA IYER (T S)

Deodorant for use in fish processing establishments. *Res. & Ind.* 18(1), 1973 : 23–24.

An effective double action cleaning agent has been developed for use in fish processing plants. The deodorant formulated was tried in fish landing places, primary processing centres and factory premises with highly encouraging results. The product was also found to have slight disinfecting and fly repellent properties. Pine oil emulsions are non-toxic, non - irritating and safe under ordinary conditions of use. A special feature of the deodorant is that it can be easily prepared in fish processing factories.

401. GOPALAKRISHNA IYER (T S)

Antiseptic ointment for better hygienic of prawn handlers. *Seafood Export J.*, 5 (9), 1973: 27–28.

Constant contact with prawn, water and ice produces certain lesions or skin eruptions on the palms of workers engaged in processing work. Work was therefore initiated to formulate an effective antiseptic ointment for quick curing of such ailments and thus to avoid contamination of processed products.

The composition, methods of preparation and application, cost of preparation etc. are detailed.

402. MADHAVAN (P) and UNNIKRISHNAN NAIR (T S)

Utilization of sardines. *Fish. Technol.*, 10 (1), 1973 : 44–51.

The paper presents the problems and prospects with regard to the utilisation of the fish by processing into canned and frozen products or by distributing in fresh state to internal consuming centres by quick transport. Results of investigations made on the utilization of sardine body oil for industrially useful products such as factice, paints, additive in lubricating oil and base for printing ink have been discussed.

Oil sardines lose their acceptability if the ice storage exceeds three days. Attempts have been made to pack sardine in refined sardine oil. Methods have already been worked out for the isolation of the highly unsaturated fraction of fatty acids, manufacture of oil modified alkyd resins, distilled fatty acids etc. from sardine oil.

403: SOLANKI (K K)

Kalpmatsya. *Souvenir 25th Anniversary of Indian Independance by Fishermen, Rajat Javanti Samati*, Veraval, 1973.

Shark has been aptly called 'Kalpmatsya' for the reason that all parts of its body can be utilised for various purposes and hence would earn a very good return to those contemplating to utilise the fish in an integrated manner. The article describes in brief the uses of shark muscle in fresh and dry conditions, method of removal of urea from the meat and preparation of various other products utilising the flesh of the fish. It also describes the uses of liver, liver oil and liver residues along with a brief account of the utilisation of shark fins and rays. Economic importance and utilisation of shark skin and other body parts such as teeth, brain, bones, eggs etc., for preparing various products and by products are also explained.

404. MADHAVAN (P) and RAMACHANDRAN NAIR (K G)

Utilisation of prawn waste : Isolation of chitin and its conversion to chitosan. *Fish Technol.*, 11(1), 1974 : 50 – 53.

A process is described for the preparation of chitosan from prawn shell waste. The process involves extraction of protein using 0.5% sodium hydroxide solution, bleaching the protein-free mass with bleach liquor containing 0.3-0.5% available chlorine followed by demineralisation with 1.25 N hydrochloric acid in the cold and deacetylation using 1 : 1 (w/w) sodium hydroxide solution at 100°C for 2 hours.

405. RAMACHANDRAN NAIR (K G) and MADHAVAN (P)

Shark fin rays : Technology of extraction *Fish. Technol.*, 11 (1), 1974 : 60-63.

A standard procedure for extraction of rays from shark fins has been worked out and the results of investigations are presented in this paper.

The process consists of treating the rays with dilute acetic acid to soften the tissue, separation of the rays by hand and drying. White fins yields almost double the quantity of rays compared to black fins.

406. GOPAKUMAR (K), IYER (K M), VASANTHA SHENOY (A), KUTTYAYYAPPAN (M P) and JAMES (M Arul).

Speciality products from miscellaneous trash fish. *Symposium on Fish Processing Ind. in India*, Mysore, 1975.

Methods have been worked out for the preparation of high quality fish flakes and fish soup powder from trash fish. The fish soup power prepared in the form of tablets was found to have a good consumer acceptance. Preliminary trials conducted showed that a high quality bacteriological peptone can be prepared from trash fish.

407. MADHAVAN (P) and
RAMACHANDRAN NAIR (K G)

Chitosan from squilla. *Fish. Technol.*, 12 (1), 1975: 81–82.

The authors give an account of the preparation of chitosan from squilla.

Chitosan prepared from squilla is white in colour and gives a colourless and highly viscous solution in 1% acetic acid at 1% level. Solution of chitosan thus prepared from squilla had a viscosity of 340 centipoises, whereas chitosan from prawn shell gave viscosity of 180–200 centipoises.

408. PRABHU (P V) and
RADHAKRISHNAN (A G)

Shrimp extract from prawn waste. *Fish. Technol.*, 12 (1), 1975: 31–34.

The paper describes a method for the preparation of shrimp protein extract from prawn head and shell waste. The process consists of extracting the protein from minced fresh prawn head and shell waste by treatment with mild alkali. neutralisation and concentration of the filtrate into a semisolid consistency. The yield of the final product is about 20% of the weight of fresh prawn waste.

409. PRABHU (P V),
RADHAKRISHNAN (A G) and
JAMES (M Arul)

Beverage preparation from fish hydrolysates. *Fish Technol.*, 12(2), 1975 : 127-130

A method for the preparation of energy food incorporating fish hydrolysates, sugar, cocoa, malt extract etc. is described. The product has good consumer appeal. The preparation does not impart any bitter taste of the hydrolysate to the final product irrespective of the type of fish used for preparing the hydrolysate. It freely mixes with hot or cold milk and the resultant drink is adjudged to be very palatable.

It was noted that the distribution of amino-acids do not appreciably vary with species of fish and the final product was almost alike in all respects irrespective of the type of fish used for preparing the hydrolysate.

410. RAMACHANDRAN NAIR (M K)
and MADHAVAN (P)

On deacetylation of chitin. *Symposium on Fish Processing Ind. in India*. Mysore, 1975.

Huge quantities of the head and shell waste from prawn processing factories which create problem of disposal have become raw material for a highly valuable industrial product, chitosan. This paper decribes a process for deacetylation of chitin with aqueous caustic soda at room temperature and at 100°C and a comparison of the viscosities of the products has been made.

411. GOVINDAN (T K)

Fresh fish utilisation in India: Ways and means for its improvement. *Seafood Export*. J., 8 (4) 1976. 29-35.

The first and foremost necessity for utilising the fish in fresh condition is an efficient distribution system. Containers employed for fresh fish transportation in our country have not undergone any change or note-worthy

imporvement through centuries. The prohibitive cost of thermocole slabs and its brittle nature are two of the main deterrents standing in the way of its wider application. For efficient distribution of fish in fresh condition, ice is the cheapest, most efficeint, and easily applicable refrigerant. Efficient and hygienic containers play an important role in packing and transportation of fish.

412. JAMES (M Arul), IYER (K M) and NAIR (M R)

Comparative study of fish ensilage prepared by microbial fermentation and formic acid ensilage. *Symposium on Handling, Processing and Marketing of Tropical Fish*, T P I London, 1976.

Ensiled fish products were prepared from jew fish (*Pseudosciaena* sp). Silver bellies (*Leiognathus sp.*) and sole fish (*Cynoglossus semifasciatus*) by microbial fermentation and by the formic acid method. Their nutritive values were compared. The liquid ensilage products prepared by both the methods were highly stable and did not require neutralization prior to animal feeding. The formic acid products gave pungent odours while the others gave agreeable odours. The protein digestion in the biological method was lower than that in the formic acid silage. In both methods, the free amino acids decreased after six months of storage. The pH of the medium did not change appreciably from 4 to 4.5 during storage.

413. MATHEN (Cyriac), JOSEPH (A C) and THOMAS (Francis)

Preparation of an instant deodorant for fish processing industry. *Seafood Export J.* 8(3), 1976: 19.

A method for preparation of a daodorant is described. Pine oil and Teepol in the ratio of 5.5 : 6 4 by volume are mixed thoroughly in a moisture free container, preferably of glass and kept for 12 hours without disturbance. The bottom layer is discarded and the golden yellow upper layer can be used as deodorant concentrate.

414. PRABHU (P V), RADHAKRISHNAN (A G) and IYER (T S G)

Chitosan as a water clarifying agent. *Fish. Technol.*, 13 (1), 1976: 69–72.

Chitosan is obtained by deacetylation of chitin with strong alkali. It is known to have very wide use in textiles, pharmaceuticals and cosmetics. Treatment with chitosan clarifies muddy waters and brings down the bacterial load of contaminated water.

A 1% solution of chitosan in acetic acid was prepared and employed for water clarification purposes. Chitosan appears to have superior qualities as a coagulant and consequently as a water clarifying agent especially for waters heavily contaminated with suspended materials and bacteria.

415. VALSAN (A P) and UNNIKRISHNAN NAIR (T S)

Utilisation of the fish waste selfbrine of fish curing industry as farm fertiliser. *Fish. Technol.*, 13 (2), 1976 : 156 - 158.

An economic method of utilisation of waste brine by converting it into a cheap and effecient fertiliser is discussed. Known volumes of selfbrine samples

were collected and evaporated to dryness by exposing them to sun in enamel trays. The yield was calculated and samples were analysed accordig to the methods of A O A C for the factors usually associated with fertilizer value. The manure salt recovered from self-brine contains nutrients like nitrogen, phosphorus, calcium and magnesium. It is a good substitute for common salt for manuring coconut plantations.

416. GARG (D K), LEKSHMI NAIR (A) and PRABHU (P V)

Protein from Jawala prawn *Acetes* sp.) and *Squilla* (*Orato squillanepa*). *Fish. Tcchnol.*, 14 (1), 1977 : 53 - 56.

The results of attempts made for developement of methods for better utilisation of less utilised crustacea are incorporated. A simple method for the isolation of protein from Jawala prawn and squilla is reported.

The Jawala prawn/squilla was blended with equal quantity of water, the chitinous matter removed and the pulp heated at 112°C for 15-20 minutes. The precipitated protein after filtration was dried thoroughly.

417. SOLANKI (K K), DEVADASAN (K) and VENKATARAMAN (R)

Edible fish powder from Dhoma (*Sciaenids* sp.) *Fish. Technol.*, 14(1), 1977: 39 -43.

Edible fish powder of high protein content was prepared from dhoma using different methods. A comparative account of the yield and quality of the products prepared by these methods are presented in this paper. The choice of method for the production of dhoma fish powder can be made in accordance with the subsequent use of the product as also the storage time expected of the product.

418. DEVADASAN (K) and VENKATARAMAN (R)

Ribbon fish:Good Scopefor better utilisation. *Seafood Export J.* 10 (1), 1978 : 25-28

Ribbon fishes (*Trichiuridae*) is one of India's important fisheries contributing about 5% of the total marine landings. In spite of the substantial landings and their good protein content, ribbon fish is not very popular as a food fish. Considering rhe quantity landed and its nutritive value there is vast scope for better and economic utilisation of this valuable fishery. In technologically advanced countries, the skin of this fish has been utilised for making pearl essence. A method of preparing pearl essence is high-lighted in this paper. The dried and laminated ribbon fish products overcome the defect of unattractive shape of the fish, yielding appealing and tasty product of good nutritive value. In Western and Far Eastern countries, smoked products from this fish are considered as delicacies.

419. MADHAVAN (P) and RAMACHANDRAN NAIR (K G)

Metal-binding property of Chitosan from prawn waste. *Proc. International Conf. on Chitin / Chitosan*, 1978.

Three samples of chitosan were prepared from a single species of prawn waste comprised of head and shell. Three different temperatures (100+2°C, 90+2°C and room temperature 28—30°C)

were employed for the stage of deacetylation. Assessments were made of the samples for their differences in metal-binding capacit. (Cu++from aqueous solution of copper sulphate) if any, as influenced by the temperature of deacetylation and its probable relationship with viscosity. The absorption of cu++ by chitosan is found to be almost independent of the viscosity of the solution. The absorption of copper from copper sulphate solution by chitosan was rapid at the initial stages, with a maximum rate of removal occurring during the first few minutes. After one hour of treatment, the reaction slowed down and became nearly complete in three hours. The capacity of chitosan for binding different metal ions (Cr + + +, Ni + +, Zn + +, Fe + + + and Mn + +) from their salt solutions was also studied. The rates of absorption of these metels were in agreement with those for copper. Viscosity and aosorption capacity of chitosan are therefore qualities independent of each other.

420. MAHADEVA IYER (K),
GOPAKUMAR (K),
SHENOY (A) VASANT,
JAMES (M Arul) and NAIR (M R)

Peptone from threadfin bream (*Nemipterus japonicus Block*) : Preparation and suitablility as microbiological grown media. *Symposium on Fish Utilization Technology and Marketing in the I P F C Region. Manila*, Philippines, 1978.

Peptone samples were prepared out of threadfin bream (*Nemipterus japonicus*) both from whole fish and from mince with and without defatting. The samples were evaluated for their ability to support microbial growth by measuring the optical densities of the growth suspension as well as total cell mass produced in broths incorporating the peptones. A 0.5 to 1 percent solution of the peptone compared favourably with that of Difco peptone taken as standard. Terrestrial as well as marine bacteria were employed as test organisms.

421. BALACHANDRAN (K K)

On utilisation of clam and mussel meat. *Industrial Fish Ass., University of Cochin*, 1979 : 6-9.

One of the best methods of processing found applicable for clam and mussel meat in terms of acceptability, storage life and ease of distribution is canning. Canning however, is a high-cost technology requiring technical expertise and other specialised infrastructural facilities. One good product for domestic cousumers is light smoked dried mussel meat. The most ideal low-cost technology which can be employed for processing clam and mussel meat is that of making pickles. Pickle can be made with smoked mussel also. Some of the processes have already been adopted by the industry and this can, definitely have an impact on the economic uplift of the rural poor engaged in collection of clam and mussel.

422. DEVADASAN (K) and
VENKATARAMAN (R)

On fish meal and our fish meal industry. *Seafood Export*, J., 11 (1), 1979: 9-13.

Fish meal is a valuable animal food rich in easily digestible protein and minerals, made from mixed varieties of cheap fishes, which can be incorporated

in suitable proportions in animal feeds to enhance their nutitrional value. In modern fish meal plants, fish oil is also a valuable byproduct which can be put to various industrial use. ISI has already laid down the standards for fish meal as live stock feed. There are basically two different methods for making fish meal. But the sophisticated method of producing high quality fish meal makes use of fresh fish as such, as the raw material. Fish meal produced in sophisticated plants will have a more or less uniform composition with a high protein content.

423. PERIGREEN (P A), LEKSHMY NAIR (A) and PRABHU (P V)

Filleting of fish and utilization of filleting waste. *Fish. Technol.*, 16 (1), 1979 : 43-45.

This paper reports the studies on hand filleting and skinning of different varieties of fishes, yields of fillets obtained from them, the possibility of recovery of picked meat from the filleting waste and utilizing the waste for the production of fish meal.

The composition of the meal was studied. The crude protein content of the meal prepared from the filleting waste of many of the fishes studied was above 50%, which is the protein content of grade 2 fish meal (1S : 4307-1967). In the case of cat fish and milk fish, the protein contents of the meal were 43.94 and 45.47% respectively. The acid insoluble ash of the meals was quite low in all the samples. The fat content of the meal was high in some of the samples of cat fish, seer fish and milk fish.

424. THANKAMMA (R), GOPAKUMAR (K) LEKSHMY NAIR (A) SHENOY (A) VASANT and JAMES (M Arul)

Protein hydrol/sate from miscellaneous fish. *Fish. Technol*,. 16 (2) 1979: 71-75.

A method to prepare fish protein hydrolysate from miscellaneous fish obtained as by catch from shrimp trawlers is outlined. Effects of temperature and concentration of the enzyme papain on the yield of hydrolysates have been determined. It is seen that within 30 min. at 55°C and pH 6.5, fish proteins can be effectively solubilised, provided the nitrogen content of the enzyme (activity 10 units mg enzyme) and substrate are maintained in the ratio 1: 30. This hydrolysate possesses the best aminoacid pattern compared to those obtained after hydrolysis for 60 to 180 minutes.

425. LEKSHMY NAIR (A) and PRABAU (P V).

Utilisation of frog waste. *Fish. Technol.*, 17 (1), 1980 : 27-30.

Commercial frog waste samples have been converted into meals by cooking at 0. 7 kg/sqcm for 30 min. draining off the stick water, pressing and drying the press cake in the sun, tunnel dryer under controlled conditions or hot air oven. Yield of the meal varied between 18.6 to 21.5% of the fresh frog waste. Chemical analyses have shown that the meals prepared from frog waste conform to standards prescribed for fish meal for livestock feed and can therefore be used for supplementation of polutry/animal feed.

426. MURALIDHARAN (V)

Ready-to-serve products from oil sardine. *Seafood Export. J.*, 12 (2), 1980: 29-30.

In this paper the author has described a simple, economic and efficient method of processing to evolve diversified products like fillets, pickles and chutney powder from smoked sardine. They are excellent products of high nutritive value which are sure to have great potential for export as well as internal marketing.

QUALITY CONTROL

427. LEKSHMY (A), GOVINDAN (T K), MATHEW (Annamma) and PILLAI (V K).

Grading of frozen prawn products for quality. *Proc. 7th Indian Std. Conv., Doc.* S-1/9 1963.

Important criteria for grading frozen prawn products for their quality include the number of white patches of dehydration, if any, in the frozen stage, discolouration of shell and meat, deterioration with spoiled pieces, black spot on shell and meat, presence of broken and damaged pieces, presence of legs, bits of veins, loose shells etc., presence of foreign matter, uniformity of size, texture and flavour. Final grading is carried out with resepct to the factors mentioned above on a score schedule, total bacterial plate count and flavour. These standards of quality were applied on a large number of frozen prawn products and the formulated standards corroborated with the results of practical evaluation.

428. GOVINDAN (T K)

Assessment of quality of ice-stored prawns. *Sci. & Cult.*, 30 (5) 1964 : 247-248.

Water soluble nitrogen and free amino acid nitrogen retained in the muscle of prawns during storage in ice is correlated with their organoleptic quality. Ice stored prawns having water soluble nitrogen above 1000 mg/ 100 mg wet muscle and free amino nitrogen above 200 mg were graded organoleptically as good and those showing values between 250 and 1000 and 150 and 200 respectively were graded fair or second quality, while below these values the prawns were graded as poor. The regular fall in the optical densities of aqueous extracts of the muscle with unhydrous reagent could be made use of in very quick determination of the quality of ice stored prawns.

429. PILLAI (V K)

Quality control research on Indian fishery products. *Indian Seafood*, 1 (4), 1964: 5-9.

The rapid increase in the production and use of frozen and canned fishery products presents innumerable problems for the fishery technologists and the bacteriologists. The quality control section of the CIFT has contributed substantially to the general improvement in the quality of manufactured fishery products in the country. A quick and accurate method for assessing the freshness of raw material is detailed in this communication.

430. MATHEN (Cyriac) and CHOUDHURI (D R)

Quality of commercial frozen lobs-

ters in relation to standards. 9th *Indian Std. Conv.* 1965.

In an attempt to study the variation in the quality of commercial quick frozen lobster tails, a general survey of the bacteriological and organoleptic characteristics of several representative samples were made. Of the 131 samples examined, 28.8% were organoleptically unacceptable and 12.7% had TPC above 500,000/g. Considering the TPC and the organoleptic quality together, 34.4% were found unacceptable. In general, a high TPC was accompanied by high occurrence of *E. coli* and *Enterococci*, although the converse was not found to be true. Changes in total bacterial load during different stages of processing and frozen storage under sanitary conditions are also dealt with. The authors have stressed the necessity of ensuring strict hygenic standards for the frozen product.

431. BOSE (A N)

Bacteria in processed fish: The problem and solution. *Seafood Exporter.*, 2 (1), 1967: 33.

It is not difficult to meet the prescribed bacteriological standard for cooked prawn or any other processed fish if the problem is clearly understood and appreciated and a few control measures are initiated and necessary procautions taken.

It is the quantity and type of bacteria present in a food material which determine whether the particular food can be considered to be safe or not. This requires careful survelliance on the cleanliness of all the materials and surfaces with which these will come in contact throughout the different stages of handling before, during and after processing.

432. GOVINDAN (T K)

Quality control in fish processing: The concept and compliance. *Seafood Exporter.*, 3 (1), 1968: 81-87.

The term quality control refers not only to the finished product but requires control of quality at the various stages of processing The object of quality control is to determine the quality of the material at the different stages of production so that in case it conforms with the stipulated standards for the different stages, the finished product can be accepted as such and if not, to implement necessary measures to correct the quality appropriately. Strict observance of the norms laid down after proper selection of the raw material is sure to ensure to reliable quality of the finished product.

433. GOVINDAN (T K)

Some common defects in prawn processing : Their sources and remedies. *Seafood Exporter*, 2(9), 1968 : 9-17.

Some of the important points to be observed to achieve high standards of quality of our processed prawn products have been enumerated. The problems facing the freezing, canning and dry prawn industries were studied and their remedial mesures are discussed in this communication.

434. PILLAI (V K)

Fish inspection in India. *Seafood Exporter.*, 3 (1) 1968: 48-57.

The scoring system followed in inspection of frozen products is the one recommended by ISI. Dehydration,

discolouration of shell and meat black spot on shell and meat, broken and damaged pieces, foreign matter, uniformity of size texture in cooked state etc. are the factors covered for frozen products, while for the canned products besides checking label descriptions, the products and the containers are examined for physical and organoleptic characteristics for size grade specifications, a schedule is followed for the purpose for inspection. Bacteriological standards for frozen and canned prawns are presented.

435. PILLAI (V K)

Quality control for the better utilisation of India's fishery resources. Proc. *Symposium on Living Resources of the Seas around India*, Cochin, 1968.

The role played by quality control research in improving the quality of fisheries products manufactured in India is reviewed. The impact of improvements in sanitary conditions in the fishing boats, primary processing centres and factories, care of water and ice supplies and measures to control the production processes at various stages, on the physical and chemical quality and bacterioiogical content of the product is discussed in detail.

436. VALSAN (A P)

New technique to control insect infestation in Masmin. *Fish. Technol.*, 5(1), 1968 : 37-42.

Masmin was spread uniformly inside a thermostatically controlled air oven maintained at a temperature of 125°C. After maintaining this temperature for 15 minutes the oven was put off and allowed to cool down to 65°C. The treated products were packed in wooden boxes with lid, glass bottles, tar-polythene lined gunny bags and ordinary 300 gauge sealed polythene bags.

Heat treatment as above followed by hermetical sealing to prevent from further contamination is an effective way of protecting Masmin from the destruction caused by insects. Insecticide costing of the containers has a certain amount of inhibitive properties on insect attack, it may not be essential when heat treatment process is adopted.

437. KRISHNA IYER (H) CHOUDHURY (D R) and PILLAI (V K).

Experiments in constituting a taste panel for canned and frozen prawn products. *Fish. Technol.*, 6 (2), 1969 : 129-133.

With a view to constituting a taste panel in the laboratory for detecting the flavour changes in canned and frozen prawn, three methods of panel selection, viz. scaler scoring method, range and deviation method and triangular method were tried. Out of the three, triangular method was found to be suitable for panel formation in canned and frozen prawn. Using this method a panel of six members was found for detecting flavour changes in the two products.

438. GOVINDAN (T K)

Grading of frozen prawns according to Indian Standards. *Indian Fd. Packer*, 24 (1), 1970 : 25-30.

With a view to creating confidence in our frozen prawn products in the foreign markets and avoiding possible rejections,

the Government of India have introduced preshipment inspection employing criteria of quality abridged from the Indian Standards formulated for them in 1962 (IS : 2237–1962). These standards are based only on organoleptic characteristics and microbiological quality. The author has given a brief account of the method of grading of frozen prawn products according to ISI standards Extensive field trails have proved their worth and satisfactory results could be achieved with a little bit of practical experience on the part of the analysts.

439. MATHEN (Cyriac)

Survey of the chemical quality of water used in the fish processing industry. *Fish. Technol.*, 8 (1), 1971: 109–111.

The paper presents data on the chemical characteristics of one hunderd samples of water used in the fish processing industry, examines the extent of dependence on private sources of water and stresees the necessity for improving the water quality. Of the total samples, only 40% were within the limits of acceptability when all the quality criteria were considered together, the limiting factor being alkalinity. Sulphate content was less than 100 ppm in 89% of the samples and copper less than 0.2 ppm in 93%. The total dissolved solid was mainly sodium chloride. The amount of sodium chloride may not influence the qnality of the processed fish as storage in refrigerated sea water or sea water ice is an accepted method of fish preservation.

440. THOMAS (Francis) and MATHEN (Cyriac)

Quality tolerances for water for use in fish processing. *Fish. Technol.*, 10 (1), 1973 : 85–87.

An attempt has been made to study the effect of varying concentrations of chemical constituents in the water used for prawn freezing and its influence on the quality of the prawn after freezing and and during frozen storage. Tho results are reported in this communication together with recommendations on the quality tolerances for water used in fish processing industry.

No significant difference in bacterial and biochemical quality has been observed between any of the treated and control samples. It appears that the tolerances for water to be used in fish processing can be the same as those for ice manufacture (IS-3957-1966) with slight modification. The level of chlorides can be upto 1000 ppm and consequently, the tolerance for total dissolved solids has to be higher. The pH should be between 6.5 and 7.5 since higher pH may cause bleaching and lower pH may cause corrosion.

441. GOVINDAN (T K)

Objective tests for fish quality. *Seafood Export J* 6 (1), 1974 : 87–91.

The author sums up the systematic studies on the evolution of universally applicable objective test for determination of the quality of fresh fish. The important spoilage products whichha ve been made use for determining the fish quality are trimethylamine and dimethylamine produced by bacterial reduction of trimethylamine oxide generally found in varying qnantities in fresh marine fish muscle, total volatile basic nitrogen for med by degradation of several compounds like amines, amino acids etc., bacterial loads including TPC and speci-

fic pathogenic organisms, all of which multiply in leaps and bounds as spoilage progresses, volatile acids formed by deemination of lower amino acids etc., and volatile reducing substances. The visual and organoleptic rating is largely relied on at present as the guiding factor and the other act as supporting evidences to the organoleptic findings.

442. MATHEN (Cyriac)

Quality control in the Indian fish processing industry: *Fish. Technol.*, 11 (1), 1974: 1-16.

The purpose of research work in fish processing industry is to make available to the consumer a product that is wholesome and palatable at reasonable prices. Quality control research is of supreme importance in achieving this objective Considerable amount of work has been done in this aspect by CIFT. Some of the noteworthy results attained during the years have been enumerated in this paper. The establishment of Codex Alimentrius in 1962 under the joint auspices of the FAO and WHO of the UN has also been mentioned in this paper.

443. MATHEN (Cyriac)

Quality control from catch to dining table. *Ind. Farming.*, 10 (10), 1975.

In the case of fish and fishery products, quality control includes all the steps taken to protect the quality of the material from catch till it reaches the consumer. The quality control activities of the CIFT may be grouped into the following categories 1) Co-operation with the ISI to formulate national standards on fish, fishery products and processes. 2) studies on process control and quality of products. 3) quality evaluation 4) Sanitary and hygienic aspects of fish processing 5) Assistance to the trade. Almost all the products meant for export are to be accompanied by a certificate of export worthiness. Frozen prawns, lobster tails, froglegs, canned prawns, fish maws. shark fins, dried fish etc. are inspected before shipment for export.

444. MATHEN (Cyriac), THOMAS (Francis) and VARMA (P R G)

Quality control in the seafood processing plant. *Industrial Fish. Ass., University of Cochin*, Cochin., 1979: 13-17.

Quality control in the seafood industry is a must in order to create, maintain and continuosly improve the product image. Only very few of the processing establishments have quality control laboratory. However, in the recent years there are occasional enquiries on the cost involved and items required to establish a quality control laboratory in the seafood processing units. Also there has been a suggestion to replace the present compulsory preshipment inspection by a self-inspection system for factories having facilities and personal for such work, It is also advisable that routine problems related to quality are handled in factory itself by its own control personal and that only problems of more serious nature requiring expertise and sophisticated facilities be referred to the Governmental agencies. In the industry, the major items that have to be tested in the quality control laboratory are: raw materials, finished products (forzen and canned), miscellaneous items like bleach liquor. detergents, and fish meal. Details of capital required, recurring expenditure etc. are shown in this paper.

445. THOMAS (Francis) and MATHEN (Cyriac)

Water In seafood processing. *Seafood Export J.*, 11 (4), 1979: 15-34.

The quality requirements of process water in seafood processing are discussed with emphasis on their physical, chemical, bacteriological and biological characteristics. Physical examination is necessary since the presence of any noticeable colour, odour or taste makes the water unputable. Chemical examination is indispensable for eliminating such dangers as lead solvency, the presece of poisonous substances for determining the hardness and suitability of the water for domestic and industrial purposes. The chief function of the bacteriological examination is the detection of faecal pollution. Biological examinations are necessary to deal with problems concerning taste, odour and filterability arising from the growth of algae when water is stored in reserve.

446. THOMAS (Francis) and MATHEN (Cyriac)

Mercury in fish. *Seafood Export J.*, 11 (1), 1979: 31-34.

Sources of mercury in the environment are both natural (the leaching of igneous rocks and discharges from volcanoes and thermal fields) and man made. About 10% of the mercury is used in agriculture, the remaining bulk being used in industry. Some fish species are able to concentrate mercury in their systems, almost exclusively in the form of methyl mercury. Recently it was noted that carp muscle contains higher mercury content (above 0.25 ppm) than other species of fish which contain lower quantities (about 0.1 ppm) from Pymatuning lake and Mosquito lake near lake Eric. The Swedish Commission on evaluating the toxicity of fish has recommended the use of the Acceptable Daily Intake (ADI) concept to evaluate the toxological risk in eating contaminated fish. The regulations normally stipulate a permitted level of mercury in fish products offered for sale, between 0.4-1 ppm. Studies conducted by the BARC by radio chemical neutron activation analysis and TNAU, Coimbatore show that the levels of mercury in fish in our country are far below the stipulated maximum levels.

BIO-CHEMISTRY AND NUTRITION

447. VELANKAR (N K) and GOVINDAN (T K)

A preliminary study of the distribution of non-protein nitrogen in some marine fishes and invertebrates. *Proc. Indian Acad. Sci.*, 47 (4) B 1958 : 202 - 209.

The non-protein nitrogen of fish muscle contributes a small fraction of the total nitrogen content of the fish. The nitrogenous extractives of fish muscle which consist of ammonia, trimethyl ammonium bases, quanidine and imidazole derivatives and miscellaneous substances such as urea, aminoacids, purines and

pyrimidines are of significance from the aspect of preservation and processing of fish. The distribution of the nitrogenous components varies in different fishes and also depends on factors such as environment, spawning cycle, season, size and age. The authors studied the distribution of non-protein nitrogen in marine fishes and some invertebrates.

The distribution of total nitrogen, total water soluble nitrogen, non-protein nitrogen, amino-nitrogen, volatile base nitrogen, glutamine amide nitrogen and trimethylamine oxide nitrogen of elasmobranchs, teleosts, crustacea, mullusca and reptilia were determined by appropriate methods. The non-protein nitrogen contributed about 10% of the total nitrogen in the teleosts, 20% in the crustaceans and molluscs and over 30% in the elasmobranchs. High levels of free aminoacid nitrogen were found in the crustaceans and mulluscs unlike in fishes. The trimethylamine oxide content varied greatly in the fishes. This compound is of special significance in the application of trimethylamine test for assessing the extent of spoilage in sea fish.

448. KAMASASTRI (P V)

Chemical properties and changes during storage of some Indian ray liver oils. 1*Curr. Sci.*, 28 (12) 1959 479-490.

Studies on commercial samples of ray liver oils showed that their acid values and peroxide values are significantly high. During storage for 5 months there was a gradual increase in the acid value free fatty acids and the peroxide value of the oil. Fall in the iodine value is significant during this period. Excepting for the high perioxide value, other charcteristics of the oil even after 5 months of storage were favourable for preparation of sulphonated oils for use in the leather industry. It is not clearly known whether the rancidity of the oil has any adverse effect on its use in the leather industry. The liver oils obtained from the *Dasyatis sp.* possess the required charcteristics for preparation of sulphonated products.

449. KAMASATRI (P V)

Studies on the Indian sardine oil, *Indian J. Fish.*, 7(2), 1960 : 443-447.

The Chemical quality of the commercial sardine oil samples was studied in detail. They were analysed and the deterioration in the quality during storage was studied along with the sardine oil prepared under controlled conditions. It was observed that good quality sardine oil can be preserved for one year without much doterioration.

450. VELANKAR (N K) and GOVINDAN (T K)

Trimethylamine oxide content of marine prawns occurring on the backwaters and in the sea off Cochin. *Proc. Indian Acad. Sci.*, 52 (4). B 1960: 111-115.

The values of trimethylamine oxide content of marine prawns belonging to different species caught from sea off Cochin and backwaters were determined It was found that there is considerable variation in the TMAO contents of individuals of the same species, depending upon their habitats. Total absence of the oxide was noted in the marine prawns taken from the backwaters where the salinity of the water was very low. The significant differences in the TMAO

contents of marine and backwater prawns show that trimethylamine test for spoilage could be applied in the case of the former, but is of little value in the case of the latter. The TMAO content of the backwater prawns even when the salinity reached the level of sea water was found to be far less than that of marine prawns

451. KRISHNA PILLAI (V), SASTRI (P V K) and NAIR (M R).

Observations on some aspects of spoilage in fresh and frozen prawns. *Indian J. Fish*, 8(2) 1961 : 430-435.

The paper deals with the changes in the chemical and bacteriological characteristics taking place during the various stages of processing. The changes in pH, trimethylamine, total volatiie nitrogen. nonprotein nitrogen, amino nitrogen and viabla bacterial count of fresh prawns during spoilage under laboratory conditions are presented. Quality changes of three different packs ie. headless, peeled and deveined and cooked frozen prawns during storage period of 13 weeks have been studied.

In the course of 24 hours variation in pH value is only of the order of one unit which clearly shows that the pH value connot be considered as an index of spoilage of prawns. The variation in TMA content during the initial period of spoilage upto 5 hours was found to be negligible. TVN changes become significant only after 8 hours of spoilage. Bacterial load indicates that the flesh of prawn is not sterile. Steady increase in the total bacterial counts occurs during spoilage and the values are significant in assessing the overall quality of the prawn. The TVN, non-protein N and alpha-amino nitrogen values of the peeled and deveined samples show a decrease after storage in the chill room and after freezing.

452. VELANKAR (N K), GOVINDAN (T K), APPUKUTTAN (P N) and MAHADEVA IYER (K).

Spoilage of prawns at 0°C and its assessment by chemical and bacteriological tests. *Indian J. Fish.*, 8 (1), 1961: 241-251.

The studies are aimed at evaluating accurately the course of spoilage in prawn. Bacterial count trimethyl amine (TMA), total volatile nitrogen (TVN), volatile acid number (VAN) free alpha amino acid nitrogen and acid soluble orthophosphates were determined at suitable intervals during the storage period.

It was found that the bacterial count of whole prawns kept in ice decreases in the initial days of storage and begins to increase after 5 days. The spoiled patterns of the peeled prawns held at 0°C showed significant rise in the bacterial count while TMA and TVN showed changes only after 2 weeks storage.

453. VELANKAR (N K) and MAHADEVA IYER (K).

On the qualitative distribution of free amino-acids in different species of prawns. *J. Sci. & Ind Res.*, 20 (2), C 1961 : 64-65.

The free aminoacid present in the muscle of prawn, lobster and crab have been examined qualitatively by paper chromatography.

Six among the eleven spots obtained have been identified as lysine, arginine, glycine, proline, valine and leucine. An overall similarity in the chromatographic pattern among the several species has been observed. The implications of the results in the application of paper chromatography to species differentiation in the crustacea have also been indicated.

454. GOVINDAN (T K)

Some new indices of quality ice stored prawns. *Sci & Cult*, 28, 1962 : 36-37.

In the case of prawns stored properly iced spoilage is very little especially in the first week of storage. The multiplication of bacteria is also retarded in the first week of storage in ice. Total nitrogen, water soluble nitrogen and non protein nitrogen were determined at different periods of storage in ice.

The absorption of moisture by the muscle from melting ice and leaching out of the soluble nitrogenous compounds from the muscle into the melt water are by far the most prominet phenomena occurring simultaneously, especially in the first week of storage of prawns in ice. Tests depending upon these phenomena are likely to give correct indication of the duration of the storage of prawns in ice. The total nitrogen, water soluble nitrogen and non-protein nitrogen values of prawn muscle which are high when prawn is fresh show rapid fall on storage of prawns in ice as a result of the combined effect of the above phenomena and these values can be associated with definite periods of storage of material in ice. The results can be used for grading the raw materials.

455. KAMASASTRI (P V), PRABHU (P V) and RAMANANDA RAO (D)

Further studies on Indian sardine-oil. *Indian J. Fish,*, 9 (1) B 1962: 84-90.

A survey of the quality of sardine oil from different places in the west coast was carried out. The physical and chemical characteristics and the storage changes of commercial oils and that extracted in the laboratory were studied.

High percentage of nitrogen and oxidised acids were noticed in the commercial samples when compared with the oils extracted in the laboratory. The dark colour of the oil was partly due to the scorching of the fish during the extraction stage when skin pigments got oxidised. The colour also depends on the degree of freshness of the fish at the time of processing. The acid value increases to 3-4 times its original when the settling period of the oil-water mixture exceeded to 72 hours. Iodine and peroxide values were not affected during this period.

456. KAMASASTRI (P V)and RAO (D R)

Some observations on the nitrogenous losses in the wet reduction processes. *Indo-Pacif. Fish. Coun.*, 1962.

The nitrogenous fractions in different fishes and fish meals prepared were determined. The losses of the above fractions in the stick water during the wet reduction process were estimated.

The loss in non-protein fraction amount to 34 - 64%, aminoacid nitrogen to the extent of 45.4 -72.4%, TVN 70.6 - 90 8%

the total volatile nitrogen chiefly constitutes ammonia. The loss in the total nitrogen is between 6.2 to 13.2%.

457. RAJENDRANATHAN NAIR (M)

Preliminary study of the changes associated with lipid breakdown in oil sardines (*Sardinella longiceps*) stored at refrigerated temperatures. *Indian J. Fish.* 9 (2), B 1962 : 126-132.

A study of lipid breakdown and proteolysis of muscle in oil sardine stored at two different temperatures 0°C and 10°C, revealed rapid proteolysis at higher temperature as shown by the amounts of total solids and nitrogen extractable into the aqueous phase of chorloform-methanol-water mixture.

Changes due to phospholipid breakdown were of relatively little importance at the two temperatures. Volatile acid number showed rapid rise after the 4th day at 10°C. Free fatty acid production was found to be influenced by the increased proteolysis rate.

TBA Number and peroxide value were found to be higher in fish stored in ice.

458 NAIR (M R) and BOSE (A N)

Studies on post mortem biochemical changes in prawn. FAO *Symposium on significance of fundamental research in utilization of fish. W. Germany*, 1964.

Studies are described on the quality and distribution of non-protein nitrogen and alpha-amino nitrogen and the loss of the taken compound and water soluble phosphates in prawns kept in ice The loss is considered mainly responsible for flavour deterioration in prawns during storage.

Colour changes in prawns during canning are discussed. Glycine has been found responsible for the sweet flavour of prawns. Ice storage and imperfect handling during processing result in a rapid loss of this component.

459. SURYANARAYANA RAO (S V) and VALSAN (A P)

On a new colour reaction for the detection of trimethylamine oxide. *Sci. & cult.*, 30. (5), 1964: 235-236.

A new chemical test was evolved to study the distribution of trimetylamine oxide in some important varieties of marine fishes. About 20g of minced fish muscle was extracted with 100 ml of rectified spirit and concentrated after filtration to 5ml either in vacuum or on the water bath. After spotting 10-20 ml of the concentrate on chromatographic paper it was developed in butanol-acetic-acid-water solvent usually employed for aminoacids The paper was finally sprayed with 2.5% aniline phthalate in water-saturated butanol, the common sugar reagent. The presence of trimetylamineoxide was revealed by a deep yellow spot after heating for 10 minutes at 105°C Rf value was about 0.33 and the test was sensitive up to 30 mg of the oxide. A rough assessment of the oxide content was made based on spot area. The values obtained by the authors were found lower when compared to the previous values reported.

460. VALSAN (A P), KANDORAN (M K) and SURYANARAYANA RAO (S V)

Note on proximate composition of

tuna fish paste from Minicoy. *Fish. Technol.*, 1 (1), 1964 : 106-103.

An indigenous method of preparing fish paste from tuna fish exclusively practiced in Minicoy island is described. Detailed proximate analysis of the product was carried out and the values were compared with those obtained for similar products of foreign countries A Chromatographic study was also carried out for essential amino acids with special reference to detecting any possibility of histamine poisoning.

The organoleptic and analytical data on fish paste from tuna collected from Minicoy are presented. It was observed that histamine was practically absent in this fish paste as in the case of Masmeen.

461. GOPAKUMAR (K)

Seasonal variation in lipid composition of oil sardine (*Sardinella longiceps*). *Indian J. Fish.*, 12 (1), 1965: 1

The contents of triglycerides, phospholipids, unsaponifiable matter and cholesterol of the fish in different seasons of the year were studied with special reference to their possible significance in the growth-cycle of the fish.

It is known that the seasonal variations in the lipids of oil sardine are due to the intensity of feeding, sexual development and eventual spawning. The greatest decrease in lipid of oil sardine was observed after spawning, while rapid increase was noticed during the months of rapid maturation. The increase in lipid content was mainly contributed by the amount of triglycerides and this variation followed a regular pattern in the fish. Unsaponifiable matter and cholesterol content of the lipids increase during the months of April, May and June.

462 RAMANANDA RAO (D) and KAMASASTRI (P V)

Some observations on the protein quality of fishmeal prepared by wet and dry reduction methods. *Indian J. Fish.*, 12 (2) B. 1965 : 7-9.

A systematic study on some varieties of thin fishes such as ribbon fish was undertaken with a view to determining the protein quality of the meals. Fish meal prepared by wet and dry reduction processes showed that protein degradation in the cooked material was less compared to the uncooked material. Drying at 105°C did not alter the available lysine value significantly if enough care was exercised to avoid scorching in wet reduction process. Drying the press cake in the sun did not significantly change the available lysine value. From the point of view of quality, it is suggested that meals prepared by the wet reduction process coupled with sun drying can be adopted in fishing villages where installation of mechanical dryers is difficult.

463. GOPAKUMAR (K) and RAJENDRANATHAN NAIR (M)

Studies on fish lipids: II – Fatty acid composition of lipids of oil sardine (*Sardinella longiceps*.) *Fish. Technol.*, 3 (1), 1966: 121.

Oil sardine were chilled in ice, descaled and deboned. The muscle with the skin was blended in mechanical blender and samples of 100 g minced muscle

were taken for analysis. Gas-liquid chromatography has been employed for the qualitative and quantitative analysis of the component fatty acids in lipids of Oil Sardine.

Fatty acid composition of the total lipid of sardine has been found to be of a similar pattern as for other species of fish. The phospholipids contain higher proportion of poly unsaturated acids than the composite lipid and non phosphorylated lipid fraction. A remarkable feature of sardine lipids is the absence of branched chain fatty acids.

464. VENKATARAMAN (R), VASUDEVA PRABHU (P) and MANKAD (D J)

Ice storage studies on Indian Pomfrets. *Indo-Pacif. Fish. Coun.*, 12, Occa. Pap. 67/8 1966.

The spoilage rates of silver pomfret (*Pampus argenteus*) and black pompfret *Parastromateus niger*) stored in crushed ice have been studied with a view to determining the actual shelf life of these fishes in ice.

Judged on the basis of chemical indices bacterial count and organoleptic qualities black pomfret deteriorates faster than silver pomfret under identical conditions of storage. This supports the common belief that fish containing greater percentage of red muscle spoil faster. Silver pomfret has very little red muscle and keeps well for at least 12-14 days in ice whereas black pomfret can be kept in ice only for 5-6 days in acceptable condition. The deposit of adipose fat and higher percentage of red muscle may perhaps be reponsible for the accelerated rate of spoilage in the case of the latter.

465. GOPAKUMAR (K) and RAJENDRANATHAN NAIR (M.)

Studies on fish lipids: Fatty acid composition of lipids of marine fish as determined by gas liquid chromatography. I - *Indian J. Biochem.* 4 (4), 1967 : 229.

Gas liquid chromatography has been employed for the indentification and quantitative estimation of the component fatty acids in the body fat of fatty fishes like mackerel and pomfret and two non-fatty fishes viz. kilimin and jew fish.

In mackerel and pomfret, fatty acid composition has been estimated separately for phospholipids and non-phosphorylated lipids. Lipids of both jew fish and kilimin contain 30-40% of C 16 acids. The polyunsaturated acids present are predominantly eicosapentaenoic and discosahexaenoic. In the mackerel and pomfret polyunsaturated acids are present in relatively larger amounts in phospholipids than in nonphosphorylated lipids.

466. KAMDAR (L D), KANDORAN (M K) and VENKATARAMAN (R)

Studies on sharkliver oil and its residue. *Fish. Technol.* 4 (1) 1967 : 21-27.

Seasonal variations of moisture contents and vitamin A potency in shark livers from different species of sharks landed at Veraval coast were studied. The values of moisture, protein, ash and vitamins in defatted liver residue were determined.

Oil content is maximum during January and February (about 58%) and decreases to minimum in the month of June (22%). From July onwards oil content increases reaching maximum in the month

of October (55%). Concentrations of moisture and oil in shark liver were found to be inversely proportional to each other. Maximum moisture and minimum oil contents were found during summer. With increase in oil content, vitamin A potency decreased. Defatted liver residue was found to be rich in protein and vitamin B contents and hence can be used as valuable blend with fish meal to enrich it with nutrients.

467. ANTONY (P D) and
RAJENDRANATHAN NAIR (M)

Studies on phenolase enzymes in prawns: I - The distribution and physical properties of phenolases in penaeid prawns. *Fish. Technol.*, 5 (1) 1968: 31-36.

The distribution of phenolases in certain species of penaeid prawns has been studied. Attempts were made to locate the regions of maximum enzyme activity in fhe prawns. The relative dopase activity has been examined in extracts from head, tail, muscle and shell with cuticle.

The head juice and tail estracts were found to register very high order of enzymic activity. *Metapenaeus affinis*, *Metapenaeus monoceros* and *Penaeus indicus* recorded comparatively higher enzyme activity than *parapenaeopsis stylifera* and *Metapenaeus dobsoni*. No definite relationship could be found between the relative activity of the enzyme and size grade. Experiments were done to determine the pH optima of the enzyme and the influence of pH on its deactivation. Exposure to higher temperatures upto 55°C activates the crude enzyme considerably.

468. VENKATARAMAN (R)
SOLANKI (K K) and
KANDORAN (M K)

Seasonal variation in the chemical composition of pomfrets: I-Black pomfret (*Parastromatus niger*). *Fish. Technol.* 5 (2), 1968 : 113-122.

The proximate composition of different parts of black pomfret with emphasis on seasonal variation was studied in detail. They were found to be very much susceptible to seasonal effects recording greatest variations in fat and moisture contents. Middle and tail parts showed the least variation. Skin and head portions exhibited greater amounts of the total fat in the fish.

The maximum fat content was observed in March, April and May, which coincided with the pre-spawning period. Moisture and fat contents displayed a strong inverse relationship to each other. The protein contents of head, middle and tail portions of the fish did not differ much. No significant difference could be noted in average value of the composition of various parts of the fish for two consecutive seasons.

469. CHERIAN (Susamma) and
RAJENDRANATHAN NAIR (M)

Preliminary observations on changes in nucleotides in oil sardine and certain penaeid prawns during chill storage. *Fish. Technol.*, 6 (1), 1969 : 36-41.

Preliminary study has been made on the changes in Common 5' nucleotides in oil sardine (Sardinella longiceps) and two penaeid prawns of Indian water during chill storage. The course of nucleotide degradation has been followed

in the fresh fish and shell fish during ice storage. Comparison has been made on the pattern of nuecleotide changes in block frozen fish and individually quick frozen fish stored at -23°C.

470 JAMES (M Arul)

Free amino acid composition of different species of prawns. *Sci. & Cult.*, 35 (10), 1969 : 590-592.

This paper gives an account of the quantitative distribution of free amino acids in different commercially important species of prawns and forms part of the programme of studies on factors determining flavour in fishery products. The species studied included, *Penaeus indicus*, *P. carinatus*, *Parapeneopsis stylifera*, *Matapenaeus affinis* and *M. dobsoni* from offshore and *P. Indicus* and *M. monoceros* from backwaters. The quantitative distribution of free amino acids in different species of prawns are given in a tabular form. Among the free amino acids, glycine registered the highest amount followed by proline, glutamic acid, alanine and arginine in order. Proline and valine were remarkably absent in one of the species, *P. carinatus*. Free tyrosine and phenyl alaine occurred in higher amounts in *P. indicus*. Lysine was relatively higher in the backwater type. Histidine was comparatively less in quantities in all species except in the case of *M. monocers*. Cystine content was found to be negligible in all species.

471 DEVADASAN (K) and RAJENDRANATHAN NAIR (M).

Observations on changes in the major protein nitrogen fractions of prawns and sardines during ice storage. *Fish Technol.* 7 (2). 1970 195-197.

The study forms part of an exhaustive investigation on changes in the major protein nitrogen fractions viz. sarcoplasmic, myofibrillar and stroma, in two species of prawns and in oil sardine held in ice storage.

Myofibrillar proteins were observed to get denatured at a rapid rate as determined by salt extractability method. The sarcoplasmic proteins were not denatured to any considerable extent in sardine, however the extraction of myofibrillar proteins was inhibited in the uniced condition by free fatty acids.

472. GOVINDAN (T K)

Non-protein nitrogen compounds in fish muscle : Their distribution and functions in the fish body and significance in quality control. *Indian Food packer*, 24 (5), 1970 : 11-15.

The more common indices of quality used universally for deciding the state of freshness of fish are : (1) trimethylamine, (2) total volatile bases (3) volatile acid number and (4) organoleptic rating, the last being subjective. All the objective tests depend on the NPN compounds present in the fish muscles. The limitations of the objective indices mentioned in this paper from the point of view of occurrence of their precursors in the fresh muscle have been pointed out. Nevertheless, in the absence of other interfering influences, the tests are capable of giving some approximate idea about the quality of the material. All the compounds measured in the tests are highly soluble in water and hence storage of the fish in ice interferes with their direct application in quality control especially under tropical conditions like ours where rate of meltage of ice is very high.

473. DEVADASAN (K) and RAJENDRANATHAN NAIR (M).

Studies on the electrophoretic patterns of fish muscle myogens. *Fish. Technol.* 8(1), 1971 : 80-82

The paper reports observations made on the disc-electrophoretic patterns of muscle myogens of certain Indian fishes and shell fishes and their usefulness in species identification. The application of the technique as extended to ice stored fish has also been discussed.

The patterns in respect of prawns and some common Indian food fishes of marine and fresh water origin were obtained on polyacrylamide gel. It was observed that the characteristic patterns were species specific and were not altered by storage of fish in ice and hence could be employed as a means of identification of fish species.

474. DEVADASAN (K) and RAJENDRANATHAN NAIR (M)

Effect of C 18 unsaturated fatty acids on the extractability of fresh muscle proteins. *Fish. Technol.*, 8 (1), 1971 : 107-109.

An attempt has been made to study some of the factors which govern the extractability of protein from teleost and crustacean muscle under the influence of certain added C 18 unsaturated fatty acids.

The effect of added linoleic acid on the extractability of muscle proteins of *S. longiceps* is summarised. The fatty acid added to the extractant cause inextractability of fresh muscle progressively with increase in concentration of the acid. The soluble protein N-content decreases regularly with added linoleic acid, a level of 0.25ml having been found to be sufficient to insolubilize essentially all myofibrillar proteins in the extract. Both oleic and linoleic acids gave similar trend of results with prawns, the effect being more marked with linoleic acid. The fish actomyosin held in solution has also been found to be increasingly insolubilized by the addition of linoleic acid depending upon the concentration of the fatty acid and length of storage at low temperature.

475. GEORGE (Chinnamma) and JAMES (M Arul)

Technological aspects of preservation and processing of edible shell fishes : Influence of season on the chemical composition of crab (*Scylla Serrata*). *Fish. Technol.*, 8 (1), 1971 : 83-88.

The paper deals with a study of the seasonal changes in the chemical characteristics of one of the important commercial species of crabs, *Scylla serrata* caught in Indian waters. Changes in moisture, protein, water extractable nitrogen, non-protein nitrogen, glycogen, lactic acid, fat and free amino acid composition of crab meat have been observed every month round the year.

The nutritive value was found to be maximum during the months of October to March. High yields of meat of the order of 30 to 35% were obtained during September to December compared to 15 to 30% during other seasons. New moon periods favoured the yield of the meat in a variety of crab studied.

476. GOPAKUMAR (K) and RAJENDRANATHAN NAIR (M)

Phospholipids of five Indian food fishes. *Fish. Technol.* 8 (2), 1971: 171-173.

A summary of the study on phospholipids of five Indian food fishes viz; sardine, pomfret, mackerel, anchovies and thrissocles which were fractionated quantitatively using column and thin layer chromatographic techniques is reported in this communication.

The results obtained from the experiments showed that phosphatidyl choline and phosphatidyl ethanolamine are the two principal components of phospholipids of all fishes investigated. Total phospholipid content expressed on wet weight of the tissue showed the minimum value, namely 0.32% for anchovies. A noteworthy feature of the phospholipids of sardine, mackerel and pomfret is that they contain a high percentage of lysophosphatidyl ethanolamine to the extent of 3.9, 3.5 and 4.2 respectively. The higher amount of PE and PC which are prone to hydrolysis may have contributed to larger quantities of free fatty acids (FFA) formed in the fish during frozen storage.

477. NAIR (M R)

Certain technological problems involved in preservation and processing of fish in India. *Proc. Symposium Current trends in food research*, Bombay, 1971.

Muscles of fish and shell fish contain large amount of free aminoacids, the presence of which is characteristic for different species. The consumption of fish in a tropical country can be stepped up only if fish is properly preserved without any deteriorative changes and without considerable loss in nutritive value. During prolonged contact with ice, fish and shell fish entail considerable loss of water soluble protein aminoacid and other nutritive factors, the extent and nature of which is found to vary with the type of fish and the manner in which it is held in ice.

478. GOPAKUMAR (K) and RAJENDRANATHAN NAIR (M)

Fatty acid composition of eight species of Indian marine fishes. *J. Sci.. Fd. Agric.* 23(4), 1972: 493 - 496.

The composition fatty acids persent in lipids of six warm water species of fishes, one sample of liver oil and the lipids of the shell fish are presented. A comparative study was also undertaken of the fatty acid composition of black and white muscle in the seer fish. Tropical fish oils were found to be relatively saturated. The species examined showed wide variations in myristic (2 to 11.3%), palmitic (20 to 35%), stearic (7 to 16%), C18 : 1 (7 9 to 24%), C20 : 5 (11.11%), C22 : 6 (2 to 10%) acids. Mussel lipids and lipids of mullet contained very high percentages of odd numbered fatty acids.

479. SELVARAJ (G S D), GOPAKUMAR (K) and RAJAGOPALAN (M)

On the occurrence of osteochondroma and osteoma in the marine cat fish (*Tachysurus jella* Day). *J. Mar. Biol. Ass. India* 15 (2), 1973 : 571 - 576.

This paper embodies a brief discription of the different types and transitional forms of tumours observed on dirferent regions of the body of three specimens of the cat fish, *Tachysurus jella* collected from the south-west coast of India The biochemical composition of the muscle and tumour tissues have been studied and the etiology of tumourigenesis in marine cat fishes are discussed. The present record is the first of

such type of skin and bone tumours reported on this species which has a fairly wide distribution in the Indian seas.

480. NAIR (M R)

Nutritive factors in relation to preservation, processing and storage. *Souvenir, Dept. of fisheries, University of Calicut*, 1973 : 16.

Besides quality protein, Indian fishes are found to be good sources of fat, various vitamins and minerals like calcium phospherus, iron and copper. The body fat of fishes like *Sardinella longiceps* contains important poly unsaturated acids C 20 : 5 and C 22 : 6. Quantitative and qualitative losses of nutritive factors in fish during preservation by icing and irradiation and processing into frozen, canned, and smoked prawns have been evaluated and measures to minimise such losses are briefly indicated.

481. ANTONY (P D) and NAIR (M R)

Studies on phenolase enzyme in prawns : II – The inhibitory action on the enzyme by certain chemical agents. *Fish. Technol.* 12(2), 1975 : 112–115.

The effect of certain chemical agents in dopa oxidation dy phenolases has been examined. Sulphur containing amino-carboxylic acids are inhibitory agents for dopa-oxidation. Tyrosine, a substrate for the enzyme also acts as an inihibitor for dopa-oxidation by the enzyme. The possible mode of action has been discussed. The function of diethyldithiocarbamate in suppressing the display of enzyme activity has been detailed and its behaviour has been compared to the other chemical agents studied.

482. GOPAKUMAR (K)

Fatty acid composition on three species of freshwater fishes. *Fish. Technol.* 12(1), 1975 : 21–24.

A comparative study was carried out on the difference in the fatty acid build up among three species viz. tilapia (*Tilapia mosambica*) (*Barbus carnaticus*) and *varal* (Ophicephalus. sp)

Fatty acid composition of freshwater fish of the three species was determined by gas–liquid chromatography. *Varal* contained the highest amount of C20:5 acid compared to other two species. Of the odd numbered fatty acids, C17 was the predominant one present. Palmitic acid was found to be in a lower level in these fish species compared to marine fish. *Barbus* recorded unusually high percentage (23.3%) of C18:2 acid.

483. GOPAKUMAR (K) and RAJENDRANATHAN NAIR (M)

Fatty acid composition of anchoviella and thrissocles. *Fish. Technol.* 12 (1), 1975 : 75–76.

The fatty acid composition of two species of fish viz. anchoviella and thrissocles was studied with a view to bringing out their possible similarities with the other members of the family of clupeidae.

Polyunsaturated fatty acids viz, eicosapentaenoic acid and docosahexaenoic acid are the two major fatty acids in the phospholipid fraction of both anchoviella and thrissocles. Myristic, palmitic and stearic acids in the nonphosporylated fraction constituted (thrissocles 47.5% and achoviella 43.5%). C22 : 6 acid was the major constituent of unsaturated fatty acids in the phospholipids (thrissocles 21.0%, anchoviella 22.7%).

C 20 : 5 was the principal component in the non-phosphorylated lipids (thrissocles 7.7%, anchoviella 3.0%).

484. GOPAKUMAR (K) and RAJENDRANATHAN NAIR (M)

Lipid composition of five species of Indian prawns. J. Sci. Fd. Agric., 26,1975 : 319-325.

The lipid and fatty acid compositions of five Indian species of prawns, *Metapeneus monoceros*, *M. dobsoni*, *M. affinis* *Penaeus Indicus* and *Parapeneopsis stylifera* were examined, phospholipids constituted 50-70% of the total lipids, with phosphatidyl choline (50%) and phosphatidyl ethanolamine (29%) as their chief components., Unsaponifiable matter comprised 21-40%, chiefly cholesterol. Triglycerides constituted only 9-14% and 34%. Palmitic acid is high, oleic low, and(20:5 generally, but not always, higher than C22:6. The only brackish water prawn M. Monoceros, though generally in conformity with the others, was found to be distinctive in several respects.

485. GUPTA (Sibasankar) and GOVINDAN (T K)

Free alpha-amino acid nitrogen contents of some common food fishes of Kakinada region, Andhra pradesh. *Fish. Technol.* 12 (2) 1975: 151 - 155.

The moisture and free alpha-amino-nitrogen contents of some important food fishes and shell fishes of Kakinada region have been studied. The free amino-acid nitrogen content of marine teleosts and elasmobranch fishes was observed to be lower than that of crustaceans and molluscs. Their probable role in physiological activities has been discussed.

486. KUTTYAYYAPPAN (M P), VASANT SHENOY (A) and GOPAKUMAR (K)

proximate compostion of 17 species of Indian Fish. *Fish. Technol.* 13 (2), 1976: 153-155.

An understanding of the proximate composition of fish species is of importance in the evaluation of their nutritional properties, particularly when the fish meat has to be processed and incorporated in various speciality products. This note reports the proximate composition of certain important species of miscellaneous fishes usually found as by - catch in shrimp trawling.

The moisture content of the different fish species varied from 71.85 to 78.08%. The highest ash content was observed in the case of long rayed silver belly (56%) and lowest in jewfish (3.2%). Sea pike showed the highest protein content (20.77%) as against the lowest in catfish (16.02%). The latter recorded the maximum lipid (5.31%), and anchovies the minimum (0.3%). Silver belly recorded the highest amount of phosphrus and calcium and lowest amount of sodium and potassium.

487. VASANT SHENOY (A) KUTTYAYYAPPAN (M P) and GOPAKUMAR (K)

Fish protein concentrate from trash fish, *Symposium on Handling, Processing and Marketing of Tropical fish*, TPI London, 1976.

Fish protein concentrate (FPC) is prepared from three trash fish species. ribbon fish (*Trichiurus Sp.*) Catfish (Arius sp) and Kilimeen (*Nemipterus* sp.) Analytical and amino acid composition of FPC samples were studied. FPC from these species contained a net protein content of over

67%. Protein efficiency ratio (PER) of FPC from catfish and ribbon fish were higher than that of casein but their net protein retention (NPR) values were lower. FPC prepared from eviscerated fish was found superior in protein content and PER to that prepared from whole fish.

488. SOLANKI (K K), KANDORAN (M K) and VENKATARAMAN (R)

Seasonal variation in the chemical composition of pomfret : II–Silver pomfret (*Pampus argenteus*) Fish *Technol.* 13 (1) , 1976 : 49–53

Seasonal variation in the poximate composition of different body regions of silver pomfret (*Pampua argenteus*) is reported. As the size increase there is gradual drop in moisture, total nitrogen and ash content with corresponding increase in the fat content. Higher percentage of fat in skin and head regions was observed. The fat content of fish was found to be higher during December than during the other months. The comparison of proximate composition of silver and black pomfrets showed no significant difference in the average values of moisture contents, whereas the fat content was 2% more and protein 1% less in silver pomfret.

489. VISWANATHAN NAIR (P G), GOPAKUMAR (K) and RAJENDRANATHAN NAIR (M)

Lipid hydrolysis in mackerel (*Rastrelliger Kanagurta*) during frozen storage. *Fish. Technol.* 13 (2) 1976: 111–114.

The hydrolytic changes in the lipids of mackerel during storage at –18°C were studied with a view to understanding the mechanism of formation of free fatty acids. Only the phosphorylated fraction did under go hydrolysis at an appreciable rate. It was found that the free fatty acid production was mainly associated with the phospholipid hydrolysis. As regards the triglycerides and unsaponifiable matter, there was no significant change in levels during frozen storage.

490 VISWANATHAN NAIR (P G) GOPAKUMAR (K) and RAJENDRANATHAN NAIR (M)

Lipid and fatty acid composition of clams (*Vellorita cyprinoides*). *Proc. of the sympos um on fats and oils in relation to food products and their preparations*). CFTRI, Mysore, 1976: 143–145.

Lipid and fatty acid compositions of clams (*Vellorita cyprinoides*) were studied by consecutive column, thin layer and gas liquid chromatographic techniques. Phospholipids of clam meat accounted for 50.71% of the total lipid content. An important feature in the fatty acid composition of lipids of clam was the occurrence to the extent of 6% of C 17 saturated fatty acids. Of the phospholipids, phosphatidyl choline (40.7%) and phosphatidyl ethanolamine (28.4%) were found to be the major constituents.

491. DEVADASAN (K) and RAJENDRANATHAN NAIR (M)

Further studies on changes in protein fractions of fish muscle during storage in ice. *Fish. Technol.*, 14(2), 1977 : 127–130.

The changes in the major protein nitrogen fractions of two commercially important fishes of Indian waters, viz. mackerel (*Rastrelliger kanagurta*) and lactarius (*Lactarius lactarius*) during ice storage are reported. The significance of the findings is discussed in comparsion with

the results of a similar study on two species of marine prawns and oil sardine.

It was observed that mackerel contains a relatively higher percentage of sarcoplasmic proteins. In this respect it resembles prawn muscle. The sarcoplasmic proteins in mackerel came down to almost 50% in 13 days and those in lactarius to 60% in 12 days. As in oil sardine, in the case of these fishes also the extraction of myofibrillar proteins from the residue after extraction of sarcoplasmic proteins was found to be inhibited to a considerable extent even in the fresh condition.

492. GOPAKUMAR (K) and SHENOY (A Vasanth)

Comparative evaluation of fish protein concentrate and functional fish protein concentrate from cat fish. *Fish. Technol.* 14 (1), 1977 : 84-88.

The results of comparative evaluation of fish proteln concentrate and functional fish protein concentrate from cat fish are presented. These were prepared from eviscerated meat of cat fish (*Tachysurus jella*). Functional fish protein concentrate was lighter, less gritty and rehydrated more rapidly than fish protein concentrate. it also seems to have higher PER and biscuits containing it at levels of 5 and 7 percent were found to less hard compared to those containing be FPC.

493. MUKUNDAN (M K) and ANTONY (P D).

Distribution of phosphorylase in some fish and shell fish. Fish. Technol., 14 (2). 1977 89-91.

Distribution of phosphorylase in a few species of fish and shell fish is presented in this paper. The possible role of this enzyme in muscular capacity and post-mortem autolysis is discussed. Among the fishes analysed phosphorylase content was found to be more in jew fish followed by lactarius, threadfin bream and tilapia. Among crustacea, sea naran showed a high concentration of more than double the amount of the enzyme than other species viz. karikkadi, poovalan and crab.

Fish which contain more of the enzyme are susceptible to rapid glycolysis, resulting in high rate of hydrolytic spoilage.

494. MUKUNDAN (M K) and NAIR (M R)

Purification and characterisation of phosphorylase from muscle of tilapia (*Tilapia mosambica*) *Fish. Technol.* 14 (1), 1977:1-6.

Phosphorylase from muscle of tilapia was extracted by water and purified by ammonium sulphate precipitation, centrifugation and repeated stabilisation. Electrophorogram of enzyme preparation showed a single optimum pH and temperature of 6.1 and 37°C respectively. Glucose and glucose - 6 - phosphate were found to be competitive inhibitors of the enzyme. Maltose and starch acted as primers for the phosphorylase reaction like glycogen.

495. RAMACHANDARAN NAIR (K G) and GOPAKUMAR (K)

Fatty acid composition of marine fish body fat. J. Fd & Tech., 14 (6), 1977. 268-270

The fatty acid compositions of the body fat of 11 species of marine fishes were determined. Lipids were found to be rich in $C_{20:5}$ and $C_{20:6}$ polyunsaturated fatty acids, $C_{18:1}$ acid being generally the dominating monounsaturated acid. Saturated acids accounted for over 40 % of the total. Lipids of squid and cuttle fish were found to be distinctly different from marine fish lipids in fatty acid composition.

496. MUKUNDAN (M K) and JAMES (M A)

Nutritional quality of some food fishes. *Fish Technol.*, 15 (2), 1978 : 85 - 87.

The proximate compositions and amino acid and mineral contents of four species of Indian food fishes namely silver jew fish (*Johnins argentatus*), Indian halibut (*Psettodes erumei*) grey mullet (*Muqil cephalus*) and pearl spot (*Etroplus suratensis*) are reported.

Calorific values of these fishes have been calculated from their proximate compositions and their amino-acid make-up compared with the available data for beef and egg. From the study it was revealed that the pearl spot is adjudged to be the most nutritive among the fishes studied, followed by Indian halibut, grey mullet and silver jew fish.

497. VISWANATHAN NAIR (P G), ANTONY (P D), GOPAKUMAR (K) and RAJENDRANATHAN NAIR (M)

Lipid breakdown in oil sardine (*Sardinella longiceps*) during frozen storage. *Fish. Technol.*, 15 (2), 1978 : 81-84.

Hydrolysis of lipids and consequent accumulation of free fatty acids and development of rancidity due to oxidation of the lipids are major problems in frozen storage of oil sardine (*Sardinella longiceps*). The course of the phospholipid breakdown, production of free fatty acids and the changes taking place in the major unsaturated fatty acids during frozen storage are described in this paper. The rate of free fatty acids production is faster in the fish, with the higher fat content. Unlike in lean fish the neutral lipids are found to contribute snbstantially to the free fatty acids most affected during storage are $C_{20:5}$ and $C_{22:6}$.

498. VISWANATHAN NAIR (P G) and GOPAKUMAR (K)

Fatty acid compositions of 15 species of fish from tropical waters. *Jour. Fd. Sci*, 1978:43.

Fatty acid composition of five species of fresh water fish, three marine fish and seven brackish water fish were determined by GLC. Among saturated fatty acids, $C_{16:0}$ and $C_{18:0}$ were found to be the dominant ones with the former accounting for 50-55% of the total. Among the monounsaturated fatty acids $C_{16:1}$ and $C_{18:1}$ and polyunsaturated fatty acids $C_{18:2}$, $C_{18:3}$, $C_{20:4}$, $C_{20:5}$ and $C_{22:6}$ were the important ones. Stinging cat fish contained the highest amount of $C_{16:1}$ (16.52%) acid. The level of arachidonic acid was fairly high in most of the fish lipids analysed. The ratio $C_{18:1}/C_{18:2}$ was found higher for marine fish than for the freshwater fish and was fairly constant for each group. The fatty acid composition of brackish water fish did not show definite pattern.

499. METHEW (P T), DEVADSAN (K) and VENKATARAMAN (R).

Liquid distribution in body and skin of four species of marine fish. *Fish. Tehnol.*, 14 (1), 1979 : 66-72.

The paper presents results of a study on the analytical characteristics of lipids from the skin and muscle of four important species of Gujarat coast fishes. Changes in characteristics like saponification value, iodine value and unsaponifiable matter of these lipids during different months of the year are also reported. It was observed that skin of silver pomfret has higher lipid content compared to the muscle. Both the skin and muscle lipids have saponification values in the range of 210-220. The skin lipid had an iodine value of 60-65 compared to 50-55 of that of the muscle. Iodine value tended to increase in both case towards April - May. In the case of black pomfret, the skin had higher lipid content with the lowest saponification and iodine values. *Hilsa ilisha* showed higher lipid content both in the skin and muscle while in *H. toli*, the skin had a higher lipid content than the muscle.

In general, the lipid content was generally high during the winter months of September - December. Iodine values generally showed a slight increase during summer (March-May). Low iodine values and high percentages of unsaponifiable matter in the lipids of muscle of *H. ilisha*, in September-January were the other noteworthy feature. Lipids of silver pomfrets also had notably low iodine values.

500. MUKUNDAN (M K), JAMES (M Arul), RADHAKRISHNAN (A G) and ANTONY (P D)

Red and white meat of tuna (Enthynnus affinis) : Their biochemical role and nutritional quality. *Fish. Technol.*, 16(2), 1979 : 77-82.

The biochemical and nutrient compositions of red and white meat of tuna are reported. Based on the data the biochemical role and nutritional quality of red and white meat are discussed. The results show that red meat is adapted for slow and continuous activity and white meat for quick but occassional activity. In spite comparatively low lysine content the red meat is adjudged more nutritious than white meat.

501. VARMA (P R G) , VALSAN (A P) and PRABHU (P V)

Transportation of fish: Biochemical changes in fish during transportaion in insulated containers. part III *Fish. Technol.*, 17(1), 1980: 41-42

The changes in the biochemical changes of different varieties of iced fish during transportation in thermocole lined second hand tea-chests from Veraval to Bombay and Delhi are discussed. The moisture increased for all the varieties except for eel and hilsa. TMAN and TVM increased in all cases. Maximum increase of TMAN and TVN was observed in seer fish.

MICROBIOLOGY

502. LEKSHMY (A).

Faecal indicator organisms in frozen prawn products: Survival of the organisms during freezing and frozen storage. II - *Fish. Technol.*, 1 (2), 1964: 143-147.

The rate of survival of different types of faecal indicator organisms like *Escherichia coli*, *Entrococci* etc. during freezing

and frozen storage has been studied. Peeled and deveined prawns inoculated with a mixed culture of the above organisms were subjected to freezing and storage at -10°F and examined for four months. *Enterococci* showed the maximum survival both on freezing and during frozen storage at - 10°F for 128 days. Coliform organisms underwent a significant reduction in the frozen block after 128 days of storage showing less than 1% of the number present originally in frozen block.

503. MATHEN (Cyriac), LEKSHMY (A), KRISHNA IYER (H) and PILLAI (V K)

Rapid procedure for the approximation of bacterial load in fishery products. *Fish. Technol.*, 1 (1), 1964 : 1-11.

The production of colour by homogenised fish material in a simplified sugar medium containing an acid indicator has been made use of for the rapid approximation of bacterial load.

The medium developed contains peptone, tryptone, yeast extract, sodium chloride and beef extract besides dextrose. The time taken for the production of pink colour in the medium was found to be inversely proporational to the bacterial load of the material under test. A simplified formula for the reaction medium has been worked out and tried extensively in experiments. The method is found to give satisfactory results for rapid assessment of bacterial load in fresh, iced and frozen prawn products.

504. MATHEN (Cyriac), LEKSHMY (A), PILLAI (V K) and BOSE (A N)

Studies on bacteriological aspects of quality assessment of fishery products. *Symposium on Significance of Fundamental Research in the Utilisation of Fish, Husum, West Germany*, 1964.

The paper reports the results on the rapid approximation of total bacterial load in raw shrimp using acid production test. Various factors influencing this test are also discussed. Comparative merits of SPC, *E. coli*, *Enterococci*, *Coliforms* and *staphylococci* as indicators of quality and hygienic conditions are discussed. The extent of occurrence of these organisms in prawns during freezing and frozen storage is presented. It is shown that *Enterococci* is a better index of faecal contamination than *E. coli*.

505. MHADEVA IYER (K) and KARTHIAYANI (T C)

Simplified procedure for the detection of hydrolysis of starch by bacteria. *Curr. Sci.*, 33 (1), 1964: 1-3.

To test the starch hydrolysing capacity of bacteria isolated from marine sources, a new method is recommended. Instead of Lugol's iodine, a minute crystal of solid iodine was placed at the centre of the cover of the inverted petridish and was gently waved over the flame. The advantages of the above method are the saving of time and reagent and the slightest traces of unhydrolysed starch could be detected, thus facilitating an accurate comparison of the extent of hydrolysis by different bacterial strains. In the modified procedure there is no risk of mechanical dislocation of the bacterial growth as happens sometimes while pouring the Lugol's iodine on the culture.

506. GOPALAKRISHNA IYER (T S) and CHOUDHURY (D R)

Investigations on sanitational aspects (microbiological) of prawn processing factories. *Fish. Technol.*, 2 (1), 1965: 133-138.

During processing, fishery products are subjected to microbial contamination from external sources, the extent of which depends upon the hygienic conditions of the factories. The studies were aimed at finding out the normal variations in the bacterial load on the utensil surfaces in the processing factories and at working out a cleaning schedule which could be effective, non-corrosive and at the same time economic.

Based on the experiments the following cleaning schedule is recommended for the utensils in the fish processing factories.

1. A preliminary rubbing with coir or brush to remove all solid organic matter.
2. Washing with a detergent (Teepol 0.5%) to remove the remaining slime.
3. Application of a disinfectant-100 ppm available chlorine, sodium hypochlorite, pH 4.0-5.0, for 4 minutes.
4. Final washing with fresh water to remove the excess of sodium hypochlorite.

507. GOPALAKRISHNA IYER (T S) and PILLAI (V K)

Relationship between product quality and bacterial load in frozen prawn products. *Nineth Indian Std. Conv.*, 1965.

Detailed organoleptic, physical and bacteriological evaluations of over 1250 commercially quick frozen samples of prawns showed that there is no significant relationship between organoleptic factors and bacterial load of the samples. It was further observed that counts of faecal indicator organisms like *E. coli* and *Enterococci* of the samples did not bear any correlation with the total bacterial plate counts of the samples.

508. MATHEN (Cyriac) and CHOUDHURY (D R)

Factors influencing colour production from the sugar medium used for rapid approximation of bacterial counts in fishery products. *Fish. Technol.*, 2 (1), 1965: 144-150.

The results of the studies carried out to elucidate the factors influencing colour production from the sugar medium used for the rapid approximation of bacterial counts in fishery products are reported. The effect of particle size, trace elements, salt soluble protein and non-protein fractions, rate of multiplication of bacteria in the medium, surface bacteria and the rate of colour production by individual strains of bacteria were studied. It was observed that the best results are obtained when a sea-water homogenate is used.

509. PILLAI (V K), LEKSHMY (A), GOVINDAN (T K), MATHEN (Cyriac) and KRISHNA IYER (H)

Survey of the microbiological quality of commercial frozen prawn

products. *Fish. Technol.*, 2 (1), 1965 : 115-125.

The paper presents the results of a bacteriological survey carried out on 2917 samples of frozen prawn. 55 samples of raw material, 35 samples of water, 4 samples of ice and 42 samples of various equipments used for processing were also studied. The survey covered a period of three years (1960-63) and comprised samples collected from some the leading processing factories in Cochin. Frozen products tested consisted of headless (Marine and fresh water), peeled and deveined and cooked frozen samples. Statistical analysis of the data shows that there is no significant variation between samples and between factories with respect to product quality. The standard plate count varied between 1.0×10^4 and 1.0×10^6 per gram for headless and between 1.0×10^4 and 1.0×10^7 for peeled and deveined and cooked frozen samples. Majority of the samples had bacterial load well within the limits prescribed for such products.

510. GOPALAKRISHNA IYER (T S), CHOUDHURI (D R) and PILLAI (V K)

Studies on the possible sources of microbial contamination of processed fishery products. *Fish. Technol.*, 3 (1), 1966: 44-51.

Sanitation is a problem of immense importance to the frozen food industry. An attempt has been made in the present study to estimate and describe in detail the nature and extent of contamination of processed fishery products. The data collected clearly indicated that if the primary processing centres are not properly organised, there is possibility of greater contamination of the product. The measures to be taken for the maintenance of becterial quality of prawn during different stages of processing are, boat decks, fish holds, fish containers etc should be washed with clear water before and after each days operations, followed by treatment with a disinfectant like chlorine at a minimum level of 100 ppm. Ice used at all stages of processing should have been prepared from well chlorinated water and the water used for washing, glazing and reglazing, chlorinated at a level of 5 ppm.

511. KARTHIAYANI (T C) and MAHADEVA IYER (K)

Quantitative and quulitative studies on the bacterial flora of fresh sardines. *Fish. Technol.*, 4 (2), 1967 : 89-97.

Plate counts at RT and 8°C on the skin with muscles and the gut contents of absolutely fresh sardines (*Sardinella longiceps*) caught off Cochin showed a seasonal variation when sampling was done over a period of 12 months. The counts of the gut contents ran parallel with those of the skin with muscle, but at a higher level of magnitude. Quantitatively the analysis of 360 strains of bacteria isolated from the skin with muscle and 100 strains from the guts revealed a very high preponderance of gram negative rods mainly of *Achromobactor*, *Vibrio* and *Pseudomonas* groups. The percentage of gram positive organisms was very low or nil at times in the ocean fresh sardines.

512. GOPALAKRISHNA IYER (T S), CHOUDAURI (D R) and PILLAI (V K)

Studies on technological problems associated with the processing of

cooked frozen prawns: Hygienic conditions in relation to bacteriological characteristics. *Fish. Technol*, 6 (1), 1969: 50-65.

The importance of sanitary practices in the processing of precooked frozen shrimps has been discussed. Several typical examples have been shown to point out the different sources of contamination of the product and the extent to which each of the factors by itself or in combination affect the bacterial quality of the final product.

Cooked material should be processed with in the minimum possible time to avoid recontamination. Personal hygiene of the workers is also important in producing and maintaining the quality of the processed product. There should be separate units for the processing of raw and cooked materials preferably with separate utensils. A scheme of processing has also been suggested for, controlling the microbial quality.

513. IYER (T S G). CHOUDHURI (D R) and PILLAI (V K).

Bacteriological aspects of frozen prawn products and their significance in quality evaluation. FAO *Technical Conf. on Fish Inspection and Quality Control*, Canada, 1969.

The paper deals with the bacteriological aspects of the freezing of prawn. The extent of contamination of raw material at different stages in proocessing, and its effect on the bacteriological quality of the finished product are discussed. Studies on the survival rates of organisms of public health significance indicate that 92 to 95% of *E. coli* and 25 to 35% of *Streptococci* are destroyed during freezing. Subsequent storage at-20°C (-4°F) considerable affects *E. coli* count while *Streptcocus* counts are not significantly affected even after prolonged storage. The higher resistance of *Streptococus* to freezing and cold storage temperatures indicated its superiority and cold storage temperatures as an index of faecal contamination in frozen prawns.

514. GOPALAKRISHNA IYER (T S), CHOUDHURI (D R) and PILLAI (V K)

Influence of season on the microbial quality of fresh and processed prawn. *Fish. Technol.*, 7(1), 1970 : 93-95.

The influence of season on the microbial quality of fresh prawn handled under tropical conditions is dealt in this paper. High incidence of total bacterial count in fresh prawns was observed during April-August, while high faecal *streptococci* and *E. Coli* were found during April-June and May-July respectively in the fresh prawn. It was found that with the increase in total bacterial count of the raw material, there is a corresponding increase in the count of frozen prawn also.

515. GOPALAKRISHNA IYER (T S) and PILLAI (V K)

Distribuiton of coliforms in fresh fishery products and environments *Symposium on Microbiological spoilage of foods*, Mysore, 1970.

The present study is to evaluate the distribution of coliform types in fishery products and to assess their sanitary significance. A total number of 1277 strains isolated from 50 prawns, 30 froglegs, 50 utensils, 20 water and 18 ice samples were used in the study. It can be seen that *E. coli* type 1 constituted

14.9 and 15.6% in prawns and froglegs respectively. In utensils water and ice E. coli 1 was found to be maximum. A aerogenes 1 was comparatively low in utensils and ice but in water it ranged upto 20%. It is also clear that a high percentage of irregular types of the order of 50% and above is followed by the virtual elimination of *E. coli* type 1.

516. KARTHIAYANI (T C), GOPALAKRISHNA IYER (T S), SURENDRAN (P K) and PILLAI (V K)

Some aspects of microbiology of fish and fishery products. *Symposium on Microbiological spoilage of foods*, Mysore, 1970.

This paper reviews the work done on the quantitative and qualitative distriburion of bacteria on freshly caught fish, pattern of changes in the flora during spoilage in ice, efrect of freezing and subsequent storage on such flora, distribution of faecal indicator organisms in fishery products and their survival during frreezing and frozen storage.

517. NARAYANAN NAMBIAR (V) and MAHADEVA IYER (K).

Common microflora involved in spoilage of canned prawns. *Fish. Technol.*, 7 (2), 1970: 116-119.

An elaborate survey was carried out to ascertain the common types of microorganisms responsible for spoilage in canned prawns. Among nearly 1500 strains isolated from bacteriologically defective cans, 60% were gram positive spore-formers of the *Bacillus* type. Other types isolated belonged to gram positive, non-spore forming rods, gram negative cocci and micrococci. No anaerobe could be isolated. The predominant gram positive sporeformers were identified as *Bacillus pantothenticus*, *B. firmus*, *B. brevis* and *B. pumilus* species.

518. GOPALAKRISHNA IYER (T S) and PILLAI (V K)

Distribution of coliforms in fish and fishery products and environments. *J. Fd. Sc. & Tceh.*, 8 (3) 1971: 146-147.

Samples used for the study were collected from the local processing factories. It can be seen that E. coli. Type I constituted 14.9 and 15.6% in prawns and frog legs respectively, whereas E. coli type II (— + — —) formed only a small percentage. *Aerobacter aerogenes* type I (— — + +) and the irregular types(— — — +, + — — +, + + + +, — — + —) were found to predominate in frog legs and prawns whereas in utensils, water and ice, E. coli I was found to be maximum. *Aerogenes* I was comparatively low in utensils and ice but in water it ranged upto 20%. Of the total irregular strainstested, — — — +, type was found to predominate (50-60%) followed by the + — — + variety (about 20-32%). It is clear that a high percentage of irregular types of the order of 50% and above is followed by the virtual elimination of E. coli type I. This leads to the conclusion that in presence of the natural flora, definite bacterial antagonism exists between these two strains in certain definite proportions.

519. IYER (K M) and PILLAI (V K).

Microbiological investigations in Indian coastal waters and the Indian ocean. *Symposium on Ind-*

ian ocean and adjacent seas, their origin. Science and resources, Cochin, 1971.

The enumeration of the heterotrophic bacteria of the surface and bottom waters, muds and plankton and of certain physiological groups had been carried out of the east of Madras in the Palk Bay and the Gulf of Mannar. The nature of the bacterial flora associated with sea water and fishes off Malabar coast had also been worked out though less exhaustively. The quantitative as well as the generic distributions of bacteria in sea water off Cochin and in fresh fishes caught therein have recently been studied. Marine bacteria producing Vitamin B 12 and certain antibiotics had been isolated from the sea water and marine muds off Bombay coast. Investigations on marine yeasts was first studied in Bombay waters and subsequent studies were made in Vellar estuary and the near shore waters of Porto Novo. The distribution of yeasts in the Indian Ocean has been studied recently during the International Indian Ocean Expedition. The occurrence of marine bacteriophages had been reported earlier at Bombay and the recent International Indian Ocean Expedition has met with bacteriophages in the bottom mud off East African coast. Valuable information on the geographical distribution, movement and the biochemical activities of bacteria inhabiting the Indian Ocean has been provided by some of the earlier Soviet Ocean Expeditions.

520. KARTHIAYANI (T C) and MAHADEVA IYER (K)

Temperature influence on the biochemical characteristics of microflora of fresh sardines (*Sardinella longiceps*). *Fish. Technol*, 8 (1), 1971: 100-101.

Analysis is made of the data gathered from a study of the bio-chemical activities of 460 bacterial cultures associated with fresh sardines landed by country boats during a period of one year and the results obtained are presented in this paper.

521. KARTHIAYANI (T C) and MAHADEVA IYER (K)

Seasonal variations of bacterial flora of fresh oil sardines (*Sardinella longiceps*). *Fish. Technol.*, 8 (1), 1971 : 69-79.

In this paper, an elaborate study was made on the qualitative and quantitative variations in the bacterial flora of fresh oil sardines in different seasons and also their biochemical reactions. It was observed that the total bacterial loads and their phosphorescent and biochemical characters were influenced by changes in seasons. During monsoon season total bacterial count was high. Mesophiles predominated during summer but phosphorescent bacteria were less. Winter favoured the selection of biochemically less active groups of bacteria.

522. NARAYANAN NAMBIAR (V) and MAHADEVA IYER (K)

Bacteriological investigations of prawn canneries: Incidence of aerobic spore-formers. *Fish. Technol.*, 8 (2),1971: 215-219.

A detailed bacteriological survey of the prawn canneries of Cochin area was carried out to study the nature and type of micro-organisms present in the factory environs and their role in causing contamination of the canned products and the results are presented in this communication. About 26% of the total of

1030 strains isolated were found to be gram positive spore-formers of the Bacillus type, the cooling water being their major source. Similar types of organisms formed the major group often met with in defective canned prawn samples picked up from the factories for examination, thus establishing a correlation between bacterial characteristics and load of cooling water and can contamination.

523. PILLAI (V K).

Bacteriological standards for fresh fishery products. *Seafood Export J.*, 3 (1), 1971 : 61–63.

In India, bacteriological standards are already in existence for certain types of processed fishery products like cooked frozen and canned prawns for export and it has been decided to extend this to fresh frozen prawns also in the near future. The survey and study conducted by CIFT of the bacterial quality of processed prawn over the years has shown remarkable improvements in the recent years. The modern views about bacteriological standards for frozen food products as emerged in the recent International Conference of Food Technologists, are some of the important points touched by the author in this communication.

524. SURENDRAN (P K) and MAHADEVA IYER (K).

Behaviour of marine microflora towards antibiotics : Sensitivity towards chlorotetracycline (CTC). *Fish. Technol.*, 8 (2), 1971 : 128–132.

The object of the present study was to determine the sensitivity of different species belonging to the major general of bacteria usually present on the body of fresh ocean caught fish towards CTC. The sensitivity of 61 cultures of bacteria isolated from fish towards chlorotetracycline (CTC) at 5 ppm and 20 ppm levels has been determined on two solid media, viz. sea water agar (SWA) and a distilled water based medium consisting of peptone, beef extract, glucose and NaCl (PBGA). The cultures employed consisted of (i) gram negative rods of marine origin viz, *Achromobacter*, *Pseudomonas*, *Vibrio* and *Flavobacterium* and (ii) gram positive organisms viz, *Micrococci* and *Corynebacterium*. Depending on the inhibition zone diameter, the order of CTC sensitivity was found to be *Pseudomonas* < Vibrio < Achromobacter as determined on PBGA at CTC levels of 5 and 20 ppm. The SWA enhanced the development of resistance in majority of the cultures as compared to PBGA. PBG broth containing CTC at less than 10 ppm exerted a bacteriostatic effect only while that containing 10 ppm or more exerted at bactericidal effect on *Achromobacter*, *Pseudomonas* and *Micrococci* cultures. The significance of these results in fish preservation by CTC is also discussed.

525. JAMES (M Arul) and IYER (K M).

Studies on isolation of Salmonella from sea foods: Comparison of enrichment and selective media for recovery of salmonella from fish. *Fish. Technol.*, 9 (2) .1972:115–121

Three enrichment broths and six plating media were compared for efficiency of detection of *Salmonella* in high numbers of coliforms (10^5/ML) and (10^8/MP) from artificially inoculated fish samples. The results are presented in the communication. Recovery experiments with *Salmonella anatum*, *S. typhimurium* and s.enteritids indicated that the two enrichment

broths viz, Dulcitol Selinite (DSE) and Selinite Cystine (SC) were equally efficient. Further, the viability of *Salmonella* inoculated into fish muscle and kept at 4°C for 48 hours was found to be not affected by the low temperature storage. Selective plating media like Xylose Lysine Decoxycholate agar (XLD), Brilliant Green Sulphadiazine agar (BGS) and Brilliant Green agar (BG) were found to be superior in performance to *Salmonella shigella* agar (SS) and Bismuth Sulphite agar (BIS).

526. NARAYANAN NAMBIAR (V) and MAHADEVA IYER (K)

Bacteriological investigations of prawn canneries: II-Incidence of *Clostridium perfringens*. *Fish Technol.*, 10 (1), 1973 : 6–14.

Prawn processing factories of the three major fish processing centres of the west coast of India, viz, Cochin, Mangalore and Calicut were surveyed to determine the occurrence of *Clostridium perfringens* inprocessing areas and in processed products. The results are presented in this paper. In a total 461 samples examined only 32(6.9%) gave positive results. The incidence of *C. Perfringens* was more in prawn guts (80%) followed by soil (50%), prawn (38%), ice (33.3%), frozen prawns (11%), swab (5.0%) and water (1.1%) and *C. perfringens* could not be isolated from canned prawns.

527. NARAYANAN NAMBIAR (V) SURENDRAN (P K) and MAHADEVA IYER (K)

Morphological, biochemical and growth characteristics of *Serratia* strains isolated from sardine *Sardinlla longiceps*. *Fish. Technol.* 11 (2), 1974 : 129–136.

Two aerobic gram negative asporogenous, red pigmented, rodshaped bacterial strains were isolated from oil sardine (*Sardinella longiceps*). Their morphological, biochemical and growth characteristics are reported in this paper. The pigment was identified to be a prodigiosene. The strains were found to resemble *Serratia plymuthica*. Effect of temperature and certain carbohydrates on pigmentation was also studied. Iron was found to inhibit pigmentation and mannitol or sorbitol removed such inhibition.

528. GOPALAKRISHNA IYER (T S), JOSEPH (A C) and MATHEN (Cyriac)

Source of salmonella incidence in frog leg processing. *Proc. Symposium Fish. Proc. Ind. India*, Mysore, 1975: 4–6.

Live frog was found to harbour salmonella in its intestine. Its relation, with regard to frog leg processing is discussed in this paper.

529. KARTHIAYANI (T C) and IYER (K M)

Bacterial flors of certain marine fishes and prawns in Cochin waters in relation to their environs. *J. Mar Biol. Ass. India.*, 17 (1), 1975 : 96–100.

Qualitatively the predominant organisms found associated with marine animals (Sardines, prawns' lobster and seer fish) are the gram negative asporogenous, rod-like *Bacilli* of the genera *Pseudomonas*, *Achromobacter* and *Vibrio*. Sea water and bottom mud samples also showed a predominance of gram negative rods, though with considerable

variation in generic composition with depth. Quantitatively the bacterial density of the sea water increased with depth, the highest aerobic count being shown by bottom mud (2.7 X 10^4 organisms/gm) and the least by surface water upto 14 meteres depth (0–90 organisms/gm). But compared to bottom mud, a 10 to 100 fold increase in the bacterial count was observed on the body of the fishes in general and a higher increase (10^3 to 10^4 fold) at the gills and highest (10^4 to 10^5 fold) in the guts of sardines have been recorded. The significance of the observation has been discussed in relation to the keeping quality of the fish. In the case of sardine, studies extending over a period of one year revealed seasonal variation in the total and luminiscent bacterial counts and in the biochemical characteristics.

530. MAHADEVA IYER (K) and NARAYANAN NAMBIAR (V).

On luminiscent bacteria from marine source. *Third All India Symposium on Estuarine Biology Cochin*, 1975,

The effect of incubation temperature on the luminiscent bacterial cultures isolated from sardine has been reported in this paper. Incubation of cultures at 37°C, room temperature and 0°C resulted in total loss to greatly reduced intensity of luminiscence at extremes of temperatures viz, 37°C and 0°C used in these experiments RT (28 $\pm$ 2°C) favoured maximum luminiscence. Biochemical characteristics of these cultures have been studied and at least in one instance, the variations in luminiscence have been correlated to particular biochemical types. Technological implication on the decrease of counts of luminiscent bacteria on sardine during ice storage of the fish is indicated.

531. SURENDRAN (P. K) and MAHADEVA IYER (K)

Development of tolerance to chlorotetracycline by marine bacteria *Bull. Dept. Mar. Sci., University of* Cochin, 7 (2), 1975: 221–229.

A study has been carried out on the development of tolerance towards chlorotetracycline (CTC) by 71 strains of marine bacteria consisting of *Achromobacter*, *Pseudomonas*, *Flavobacterium* and Micrococci. Since sea water was found to partially deactivate the antibiotic, a distilled water based medium containing appropriate concentration of NaCl that supported the growth of the cultures was used to assess the tolerance build up. By growing the bacteria in a progressively increasing concentration of CTC at a challenging but nonlethal level in a suitable medium, tolerance to CTC could be developed. *Pseudomonas* and *Achromobacter* developed rapid tolerance towards CTC upto 30 ppm and 40 ppm respectively. *Flavobacterium* cultures developed tolerance to 7 to 16 ppm CTC and *Micrococci* to 16 ppm by successive subcultures.

532. SURENDRAN (P K) and MAHADEVA IYER (K)

Bacterial flora of fresh and iced Indian mackerel (*Rastrelliger kanagurta*) and its response to chlorotetracycline (CTC) treatment. *Fish. Technol.*, 13 (2), 1976: 139–145.

The natural flora of the Indian mackerel consisted of *Vibrios*, *Pseudomonas*, *Achromobacter* *Flavobacterium*, *Corynebacterium* *Micrococci* *Bacillus* and yeasts. About 90% of the fresh fish flora was sensitive to 5ppm CTC. In CTC insensitive flora *Vibrios* predominated, follwed by yeasts.

At the time of spoilage, *Pseudomonas* were found to be the dominant flora of the fish stored in ice and in 5 ppm CTC incorporated ice.

533. PANDURANGA RAO (C C) and GUPTA (S S).

Enteropathogenic *E. coli* and other coliforms in marine fish. *Fish. Technol.*, 15 (1), 1978: 45-47.

In view of the potential importance of the occurrence of coliforms especially enteropathogenic *E. coli* in fish, the present study was undertaken. One hundred and twenty six samples of marine fish (96 from landing centre and 30 from retail market) and swabs from deck surfaces of 34 fishing boats were examined for coliforms including enteropathogenic *E coli*. 40 out of 96 fish samples from landing centres, 24 out of 30 from retail market and 11 out of 34 from fishing boats revealed coliforms. On fourteen tests 5,7 and 4 coliform isolates from the three groups respectively were found to be *E. coli*. Two of the *E. coli* isolates, one from scianeids and one from cat fish, were found to be enteropathogenic serotypes 055 and 0111. Enteropathogenic serotypes of *E. coli* are reported from scienids and cat fish for the first time in this country.

534. IYER (K M)

Microbes and fresh fish. *Ind. Fish. Ass. University of Cochin*, Cochin 1979 : 18-20.

Spoilage of fish can start from outer surface as also from inside. While spoilage from inside can occur under certain exceptional conditions, spoilage from the surface of fish depends always on the extent of bacterial contamination from unclean deck-surface, dirty ice and unwashed fish containers. While taking every precaution to prevent such contamination even more important is chilling the fish rapidly so that micro-organisms already present are not given any chance to multiply quickly.

535. THAMPURAN (Nirmala) and MAHADEVA IYER (K)

Studies on the growth temperature ranges of bacteria isolated from fresh sardine at different primary incubation temperatures. *Fish. Technol.*, 16 (1), 1979 : 15-18.

This investigation was undertaken to study the growth temperature ranges of micro-organisms associated with fresh marine fish and also to gain an insight into the appropriate incubation temperature needed during bacteriological examination of fresh uniced fish. since such a temperature is likely to facilitate maximum recoveries of bacteria from the sample being examined. The effect of primary incubation temperature on the growth temperature range was studied with reference to 296 bacterial cultures isolated from sardine using streak plate technique. The primary incubation temperature used during bacteriological sampling caused a selection of strains according to their growth temperature requirements. Incubation at 8°C caused greater recoveries of psychrotrophs. while 37°C favoured; mesophiles. An incubation temperature of 30°C facilitated the growth of both psychrotrophs and mesophiles.

536. BERI (H K)

Bacteriological status of Fresh Fish at Veraval. *Symposium on Coastal Aquaculture* Cochin, 1980.

The paper presents the bacteriological status of marine fish being consumed/ processed at and also being exported to different parts of India from Veraval (Gujarat). The presence of various micro-organisms having public health significance was ascertained by the bacteriological methods. Fishes of different varieties, such as silver pomfret (*Pampus argenteus*) black pomfret *parastromateus niger*), Dhoma (*Otolithus* sp.) Eel (*Muraenesox talabonoides*). Hilsa (*Hilsa ilisha*), seer fish (*Scomeromorous guttatus*) catfish (*Tachysurus caelatus*), perches (*Argyrops sp.*), ribbonfish (*Trichiurus sp.*), and dai (*Chirocentrus dorab*) were subjected to analysis for the presence of total colony forming units of bacteria, faecal *Streptococci*, *Staphylococci* and Salmonella.

The revelation that the majority of analysed fish samples invariably showed the presence of *Escherichia* coli and faecal *streptococci*, should help the Public Health Authorities in improving the quality of fish.

537. NARAYANAN NAMBIAR (V).

Bacteriology of spoilage of canned prawns. *Fish. Technol.*, 17 (1), 1980: 35–39.

Spoilage characteristics of different types of bacteria isolated from bacteriologically defective cans and processing factory environs were studied by inoculating pure cultures into sterile prawn meat. The pattern of spoilage, namely, production of off odour, bulging of the cans and disintegration of meat were observed. Data on spoilage, under aerobic as well as anaerobic conditions are presented. Most of the cultures produced some kind of spoilage though differences were observed in the extent of spoilage produced by different types of bacteria. Gram positive spore formers were found to be the major spoilers and the extent of spoilage was more with mixed cultures.

538. SURENDRAN (P K) and MAHADEVA IYER (K)

The Bacterial Flora of Pearlspot *Etroplus suratensis* caught from Cochin backwaters. *Symposium on Coastal Aquaculture* Cochin, 1980.

Quantitative and qualitative studies on the bacterial flora of freshly caught pearl spot *Etroplus suratensis* from Cochin backwaters were made. The aerobic bacterial count on the surface of the fish varied between 10^3–10^4/cm^2 of gills between 10^4–10^6/gm and of intestines with contents, between 10^5–10^8/gm. Qualitatively the flora on the skin, and of the gills and intestines consisted mainly of as porogenous rods. The predominating flora on the skin surface consisted of *Pseudomonas* spp. (25%), *Alcaligenes* spp. (10%), Micrococcus spp. (20%), *Flavobacterium* spp. (5%) Bacillus spp. (5%) and "Coliforms" (5%) The flora of the gill tissue comprised of mainly Pseudomonas spp. (35%), Alcaligenes (25%) and Micrococci spp. (15%). The intestinal flora consisted of Pseudomonas spp. (50%), Coliform (20%), Flavobacterium spp. (8%) and Alcaligenes (6%).

ENGINEERING

539. DESHPANDE (S D).

On the comparative catch efficiency of hand operated and winch-operated trawls. Indian J. Fish., 7 (2), 1960 : 458-470.

A comparative study showed that the which operatad trawls could be manned with less number of crew and could efficiently handle a bigger net in lesser time of operation than hand-operated trawls. While comparing the mouth-opening of the nets of identical design it was found that the opening was more in the case of fully mechanised craft.

540. VELU (M)

Warping winch. *Res. & Ind.*, 8 (3), 1963: 67-68.

A warping winch designed by the author is described. It consists of a worm wheel housed in a cast iron case. Two warp heads are keyed to the shaft of the wheel, one on either side. The winch is driven by the engine by means of a V-Belt and through a jockey-pulley-gear or any other clutch.

541. SWAMINATHAN (M)

Design of a half ton dehydrator for fish. Fish. Technol., 1 (1), 1964: 76.

A half-ton capacity artificial dryer has been designed for drying fish like mackerel, sardine, white bait etc. Thermostatically controlled heating coils of 80 K. W. are made use of for heating the air. The hot air is circulated by means of an axial flow pattern fan.

542. VELU (M)

Instrument for measuring the pitch and blade thickness of marine screw propellers. *Res. & Ind.*, 9 (6) 1964: 160-163.

A simple and accurate instrument has been designed and fabricated by the author to measure the pitch and blade thickness at various points of a marine screw propeller. The Instument can be utilized by Pattern makers finishing shops, boat yards, etc. accurately and conveniently as these measurements are very difficult and cumbersome with the existing instruments.

543. BOSE (A N)

Role of refrigeration and environments in fisheries technology. *Symposium on refrigeretion*, air-conditioning and enviromental control, Kanpur, 1966.

Refrigeration for fresh fish on board the fishing vessel can be achieved by taking ice on board. Provision for refrigeration equipments on boats of less than 55 ft. length is not practicable. The use of refrigerated sea water kept circulating at $-2^{\circ}C$ to $-4^{\circ}C$ cools tha fish more quickly and effectively.

544. SREEDHARAN NAMBOODIRI (K),

Preliminary expriments on electrical fishing in fresh water. *Fish. Technol* 3 (2), 1966: 133-145.

Fishing using electricity is a new technique and is still in the experimental stage in many of the advanced countries. Experiments on electrical fishing were conducted with a view to studying the distribution of electrical field when an alternating current is passed through two fixed electrodes in fresh water. The reactions of different fresh water fishes in the field are incorporated in this paper.

545. RAO (C V N)

Refrigeration in fish handling and transport Aircond & Ref in India. 5 (3), 1967 : 13.

This paper highlights the necessity for development of a well-knit refrigerated/ insulated transport system, with facilities of cold storage, ice plants, refrigerated vehicles for effective distribution of fresh fish from coastel areas to internal markets. The paper also deals with modified baskets developed at the Institute for extended shelf life of iced fish. Results of field survey conducted on icing practices of fresh fish and temperature fluctuations during the transport of frozen prawns are also given.

546. SREEDHARAN NAMBOODIRI (K)

Impulse generator for electrical fishing. *Fish. Technol.*, 4 (2), 1967: 65-70

Since Impulse current has been found to be more economical and more effective for conducting electrical fishing, an impulse generator was designed fabricated and tested by the author. The principle and description of the impulse generator are detailed in this communication.

547. RAJENDRAN (R) and RAO (C V N)

Fish room insulation. Aircond & Ref. In India, 6 (2), 1968 : 13

Investigation on effective insulation using expanded polystyrene for holds of fishing boats of CIFT designs (9.15m to 14.9m OAL) was carried out. Total neat losses for each type of fishing vessel under normal conditions for insulation thickness 50mm-102mm are discussed.

548. AYYAPPAN PILLAI (S)

Role of refrigeration in fish processing industry. *Indian Fd. Packer*, 23 (3), 1969: 18-20.

Refrigeration is playing a very important role in fish processing industry. In this paper, the author has discussed the various freezing methods such as sharp free zing, best freezing plats freezing etc. The effect of temperature, humidity, packaging and glazing on the quality of frozen fish has been described in detail.

549. GOVINDAN (T K)

Electricity goes a fishing. *Seafood Export J.*, 1 (12), 1969 : 31 - 34.

Fishing with electricity is an invention of very recent origin and because of its several advantages, it appears to have a promising future in the development of the fishery industry. The basic principles involved in this method and the advantages of impulse current on the neurophysiological effect on living beings are discussed. Since the threshold voltage required for stunning or narcotising fish is specific to species and size, selective fishing is possible in both fresh water and sea fisheries.

550. SREEDHARAN NAMBOODIRI (K) and VARGHESE (M D)

Narcotising impulse threshold values of certain fresh water fishes. *Fish. Technol.*, 6 (1) 1969: 9-13.

Experiments were conducted to determine threshold values of impulse rate for narcotising certain fresh water fishes and the results are reported in this paper.

The effect of impulse current on the fish at a particular impulse rate and voltage depends on the size and kind of the fish. It is directly proportional to the temperature and inversely to the conductivity of the medium.

551. VELU (M)

Totally enclosed mechanical power isolation clutch. Res. & Ind., 14(4) 1969 : 190-191.

Power-take-off clutches used in fishing boats are very often damaged by corrosion. Oil and dirt get in between the working surfaces and affect the working of the clutch adversely. A totally enclosed clutch which obviates these draw backs, is developed and a diagramatic descripton of it is presented in this communication.

552. VELU (M)

Mechanical device for eradication of submerged aquatic weeds. Fish. Technol., 6 (1), 1969: 18-25.

This papar embodies details of construction and method of operation of a mechanical device developed by the author for eradication of submerged aquatic weeds.

The equipment can be operated in four combinations, viz, partially mechanised operation with one rakes, partially mechanised operation with two rakes, fully mechanised operation with one rake and fully mechanised operation with two rakes, It is effective in clearing underwater rooted weeds. The method is cheaper than manual method of removal.

553. VELU (M)

Machine for eradication of under water weeds. *Seminar on Ecology and Fisheries of Freshwater Reservoirs*, CIFRI, Barrackpore, 1969.

Acuatic weeds pose a serious problem to fisheries, navigation, agriculture and irrigation by their uncontrolled growth and rapid propagation. Various methods have been tried for removal of these weeds. Cleaning by manual method, through quite suitable for removal from small and shallow water areas. is not suited to medium and larger water spreads. The machine developed by the CIFT has been found successful after extensive laboratory and field trials. The author in this paper has briefly described the machine for the eradication of the under water weeds.

554. VELU (M) and SIVADAS (T K)

Indigenous substitutes for 'Lignum vitae' for making stern bearings for fishing boats Fish. Technol., 6_(1) , 1969: 14-17

The indigenous timbers that are use or making stern bearings for fishing boats are Guaiacum officinale, Acaciachundra, Mimusops littoralis and Hardwickia birata. These timbers have wearing properties which compare favourably with those of Lignum-vitae. Present studies have shown that Lignum-vitae causes only very little wear on the propellor shaft compared to tndigenous timbers. Bearings with an initial moisture content of 12-20%, which is normally the moisture content of air dried timbers. may be machined as a 'push pit' in the stern tube and a free sliding fit on the propeller shaft.

555. BOSE (A N) and RAO (C V N)

Cryogenics and fish preservation. Seminar at Indian Institute of Chemical Engineers, Calcutta, 1970.

This paper deals with the preliminary studies on the preservation of fish by solid carbondioxide and liquid nitrogen.

556. CHAKRABORTHY (P K).

Equipment for removal of sand from beach-dried spratts. Res & Ind., 15 (1), 1970 : 32-35.

A simple equipment designed and fabricated using indigenously available materials for removal of sand from dried fish is described in this communication. The equipment consists of a wire mesh drum provided with three horizontal coir brushes supported on a central shaft. The drum and the brushes rotate in opposite directions providing the desired abrasive action for cleaning the fish. The operational conditions for attaining maximum cleaning efficiency have been worked out.

557. CHAKRABORTHY (P K), AYYAPPAN PILLAI (S) and BALACHANDRAN (K K)

Small scale fish meal dryer. *Fish. Technol*, 7 (2), 1970 : 164-168.

A batch type rotary drum dryer for the production of fish meal suitable for operation in fishing villages has been designed and fabricated successfully. The results of certain experiments carried out in the above dryer are discussed.

The dryer can be ussd for production of fish meal from whole lean fish or presscake obtained from fish body oil extraction plants. The drying time taken to reach a moisture level below 10% is 5-8 hours depending upon the type of material fed into the dryer.

558. AYYAPPAN PILLAI (S)

Automatic brine dispenser. *Res. & Ind.*, 16(2), 1971: 121-122.

An automatic brine dispenser designed and fabricated by the author for delivering correct quantities of brine into cans in prawn canning operation has been described. The dispenser enables the delivery of brine with greater speed and accuracy compared to the conventional manual filling.

559. CHAKRABORTHY (P K) and KRISHNA IYER (H)

Mecnanised peeling table for prawn processing factories. *Fish Technol.*, 8 (1) 1971 : 101-103.

A prototype mechanised prawn peeling table was designed and fabricated and the details are presented in this paper.

The mechanised peeling table renders the raw material flow regular and uniform. The waste materials are also discharged automatically using rubber coated conveyors. Hand peeling and size grading could be done simultaneously resulting in additional gain for the factory owner by increasing the processing capacity of the plant. Effective quality control measures can also be successfully adopted.

560. SREEDHARAN NAMBOODIRI (K)

Development of an electric shrimp trawl : Reaction of shrimps to low volt direct current. *Fish. Technol.*, 8 (1), 1971 : 48-50.

Preliminary attempts were made to assess the effect of direct current on shrimps in scaring them into the fishing net.

When the shrimps are between the two electrodes, they jump at voltage below 12. The voltage required for causing this reaction in shrimps when they face the cathode was found to be lower than that required when they face the anode.

561. VELU (M)

Engines for fishing boats : Criteria for selection 1. *Indian Seafood*, 9 (1), 1971 : 21.

The various requirements which directly or indirectly influence the final selection

of marine diesel engines for propulsion of fishing boats are discussed.

It is imperative that an engine should be as small as possible in over all size. An unduly heavy engine means carrying unproductive dead weight which increases displacement resulting in higher fuel consumption and reducing useful load of fuel or fish that can otherwise be carried.

562. VELU (M)

Engines for fishing boats : Criteria for selection II. *Indian Seafood*, 9 (2), 1971 : 21.

A general idea of the important points to be considered for selection of engines for fishing boats is given in this communication.

563. SREEDHARAN NAMBOODIRI (K) and VARGHESE (M D)

Eradication of predatory fishes in fish ponds and nursery ponds using electricity. *Fish. Technol.*, 10 (2), 1972 : 116-119.

This paper deals with the use of electricity for eradication of predatory fishes in ponds.

With the moving electrode method it was not possible to completely eradicate the fish in the pond eventhough it was possible to catch bigger fishes. By electrical filtering and fixed electrode method, it was not possible to collect the stunned fishes because they were not within reach from the bank. To get the best result out of the moving electrode method, impulse current is made use of.

564. VELU (M)

Design considerations for trawl winches. *Fish. Technol.*, 9 (2), 1972 : 159-168.

The author describes certain guide lines for designing trawl winches. For efficient functioning of trawl which it is essential that all component parts should be designed carefully taking into consideration all the relevant factors such as quantum and type of load each component is subjected to, amount of maintenance it will receive during actual operation, type of drive for winch etc. Failure to take into consideration all the relevant factors in designing a Winch quite often results in operation trouble, seriously jeopardising the proper working of the boat.

565. VELU (M)

Standardisation in fishing industry: Urgent need for more national standards. *ISI Jubilee Convention*, 1972.

With a view to give the importance of standardisation of the various equipments and accessories that are used commonly in the fishing industry, the author, in this paper has brought out the need for standardisation of fishing crafts, and all equipments including engines, stern gear and other mechanical fishing accessories.

566. GOVINDAN (T K)

Electricity adds new dimensions to fishing. *Hindu Weekly Magazine*, 11 th March 1973:13

If a direct current is passed through water containing microscopic organisms, planktons are attracted towards the anode. It was further observed that the

same principle holds good in the case of higher orders of acquatic life also, viz. fishes. Several factors like voltage of the current, size of the fish and conductivity of water determine the intensity of the shock imparted to the fish. Impulse current has a much greater neuro-physiological effect on living beings including fish than direct or alternating currents. Pulsating current is particulary suited for electrical fishing as it leaves the least after-effect in the fish. Studies are in progress to develop an electric shrimp trawl which can give shocks to shrimps.

567. VELU (M)

Hydraulic equipment for fishing boats. *Seafood Export* J., 9, 1973: 21-25.

Hydraulic drives and equipments possess certain important advantages over mechanical systems. A hydraulic winch possesses higher starting torque, better acceleration and flexibility of operation. Hydraulic deck equipments such as, trawl winch, line hauler, power block, bridge controls and steering gear are increasingly being used in fishing boats. A few designs of these equipments developed by the author are detailed.

568. VELU (M), ALAGARSWAMI (K) and QASIM (S Z).

Technique of producing spherical shell beads as nucleii for cultured pearls. *Indian* J. Fish., 20 (2), 1973 : 672-676.

A process for the production of spherical beads from the shells of the Indian conch, *Xancus pyrum*, has been developed. These beads are used as nuclei for cultured pearls. The equipment consists of a grinding attachment fitted to an ordinary bench drill. Two pairs of carborundum wheels, coarse and fine, are used for grinding the beads. The finished beads compare favourably with those used in the pearl culture trade in Japan.

569. AYYAPPAN PILLAI (S)

Design of refrigerated sea water plant for preservation of fish. *Fish. Technol.*, 11 (2), 1974: 142-144.

To study the feasibility of employing refrigerated sea water on board fishing vessels for the preservation of fish, a pilot model of refrigerated sea water plant has been designed, the details of which are presented in this paper. The advantages of installing the RSW plant on board fishing vessels are also described in detail.

570. AYYAPPAN PILLAI (S).

Application of refrigeration to sea food industry. *Proc. Refrl. and Aircond. Seminar*, 1974.

Even though several methods of preservation have been employed for fish such as, dehydration, curing, canning and freezing, the last one has become more popular owing to the reason that the frozen product is subject to the least deterioration of quality compared to all other methods of preservation.

Air blast freezers and contact plate freezers are the common types in Indian seafood industry. Other types are immersion freezers and sharp freezers. Liquid nitrogen has been used in refrigerated transport and in freezers for individual quick frozen (IQF) shrimp in many of the developed countries. Maritime States are

developing freezing plants and refrigerated trucks. The refrigerated rail wagons properly arranged can from the cold chain from one State to the other, thereby a national cold chain can be established so that fish from any part of the coastal areas can be distributed to the consumer at any other part of the country.

571. AYYAPPAN PILLAI (S) and VELU (M).

Indigenous production of refrigeration equipment and machinery for the fishery industry. *Proc. Symposium on Fish Processing Industry in India*, Mysore 1975: 58.

Refrigeration plays a very important role in preserving fish from the time they are caught till they reach the processing plants as well as during processing. Machinery for producing ice required in chilling the fish are available indigenously. But difficulties are experienced in procuring freezing equipments of the right quality though a few models of freezers of indigenous make are available and are being used. There is considerable scope for the improvement of these freezers especially with respect to freezing time. Present status of availability of refrigeration equipment for processing of fishery products and future developments are discussed.

572. CHAKRABORTHY (P K)

Multi-deck tunnel drier : A new concept in hot air dehydration of fishery products. *Proc. Symposium on Fish. Processing. Industry in India*, Mysore, 1975 : 114.

The concept of a multi-deck tunnel dryer by superimposing three tunnels, each representing a theoretical drying zone, has been described. Air flows in a zigzag fashion from bottom upwards and material flows countercurrent to it. The dryer is efficient, economical, and occupies less floor area per unit load of material and lends to better control of drying parameters. Drying time for most of the fishes is below 12 hours at 45-50°C and 60-65% RH which is shorter by 3-4 hours than conventional tunnel drying of fish under identical condition.

573. CHAKRABORTHY (P K).

Artificial dehydration in seafood industry. *Seafood Export J.*, 7 (6), 1975: 9-16.

The most important group of dryers widely used for dehydration of fish are hot air dryers. The merits and demerits of some of them like cabinet dryer, tunnel dryer, multideck tunnel dryer and fluidised bed dryer are discussed. All types of rotary dryers, viz. rotary drum drier, direct rotary dryer/flame dryer indire or steam tube dryer, consist of cylinderical shell mounted on horizontal or at slight angle on rollers or bearings so that they can be rotated by suitable drive mechanisms. These types of dryer are generally used for fish meal production. Vacuum dryers are used for drying fish at lower temperature by the application of vacuum and the evolved vapour is condenced in a condenser. Vacuum dryers such as vacuum shelf dryer, freeze dryer, vacuum double drum dryer and rotocone vacuum dryer are some of the dryers discussed by the author.

574. CHAKRABORTHY (P K) and AYYAPPAN PILLAI (S)

Application of cryogenics in fish processing. *First National Symposium on Cryogenics*, Kharagpur, 1975.

This paper describes the application of cryogenics for freezing and transportation of fish. Modern IQF freezer for prawn using liquid nitrogen and liquid freon-12 and refrigerated transport vehicle using liquid nitrogen and solid carbon-dioxide (dry ice) have been described and their merits compared with the conventional mechanical system. Technical advantage of cryogenic system of freezing of sea-foods have been briefly discussed. The refrigeration capacity of dry ice is the highest but liquid nitrogen is more ideal for freezing fish. It takes about 1.25 kg of liquid nitrogen for freezing one kg of fisn (prawn) in less than 10 minutes in an IQF freezer. However, cryogenic refrigeration is comparatively costlier than conventional mechanical system due to the high cost of the refrigerants.

575 CHAKRABORTHY (P K)

Edible fish powder: An ideal solution to the problem of malnutrition. *Seafood Export J.*, 8 (8), 1976: 11-17.

This paper describes a process for the preparation of low cost fish powder retaining all the characteristics of dry fish from by-catch fishes of trawlers. The process is simple and hygienic and reqires only very few pieces of equipments. An estimate of the cost of production on pilot scale works out to Rs.5300/-per ton of powder.

576. CHAKRABORTHY (P K)

Design of a commercial dehydration plant and economics of production. *Symposium on Handling, Processing and Marketing of Tropical Fishes*, TPI, LONDON, 1976.

This paper deals with the design and fabrication of a one ton tunnel dryer for dehydration of fish A layout showing the details of dehydration plant has been incorporated. Approximate estimate of the economics of production of dehydrated fish has been worked out.

577. CHAKRABORTHY (P K).

Pilot plant for fish protein concentrats. *Fish. Technol.*, 13 (1), 1976: 62-68.

This communication deals with the design aspects and functions of individual pieces of equipment of a pilot plant of 50kg capacity per day for the production of fish protein concentrate (FPC). Design is based on a solvent extraction process of wet pressed cake with an azeotropic mixture of hexane and ethyl alcohol. A flow sheet for the process and equipment layout has been indicated.

578. CHAKRABORTHY (P K)

Solar dryer for drying fish and fishery products. *Res. & Ind.*, 21 (3), 1976: 192-194.

A dryer for drying fish and fishery products utilizing solar energy is described. It comp ises means for heating air by solar radiation and a blower for circulating the heated air through a tunnel provided with arrangement for holding aluminium trays. The dryer is simple in construction and is particularly suitable for use in tropical regions. The fish can be dried at 45°C average temperature within 13-15 day-light hours to 20-25% moisture level.

579. CHAKRABORTHY (P K) and JAMES (M Arul)

Pilot plant for production of fish ensilage and the economics of production. *Fish. Technol.*, 13(2), 1976 : 115-120.

This communication describes the design aspect and functions of individual pieces of equipment of a pilot plant for the production of fish ensilage based on lactic acid fermentation process. Details about the equipment, process flow sheet and layout of the pilot plant are given. An estimate of the cost of production of liquid ensilage and solid feed mix has been made.

580. SREEDHARAN NAMBOODIRI (K)

Reliability and need for standardisation of electrical systems in small wooden fishing vessels. *Fish. Technol.*, 13 (1), 1976 :1-3.

The working condition and atmosphere in a wooden fishing vessel are generally most injurious to the electrical systems. Therefore great care has to be taken in designing electrical systems for small crafts. This paper deals with the difficult operating conditions and stresses the need for standardisation of electrical systems in small fishing vessels.

581. CHAKRABORTHY (P K) and MADHAVAN (P)

Pilot scale set up for the manufacture of fish hydrolysate. *Fish. Technol.*, 14 (2), 1977: 159-164.

This paper describes a set up for a pilot plant with a capacity of 50 kg raw material per batch for the production of fish hydrolysate by enzyamatic hydrolysis. Process flow sheet and complete specifications and functions of individual equipment have been described. Multifunctional epuipment designed for this pilot plant set up has reduced the number of items considerably.

One such item is a stainless steel reaction vessel which has not only been used as a reactor for conducting enzymatic hydrolysis of fish protein, but also for conducting other steps like cooking solvent extraction, removal of solvent from the extracted mass and recovery of solvent from the spent solvent, sterilization, mixing of ingredients and concentration of hydrolysate, This vessel can be operated under vaccum or under pressure at varying range of temperatures while keeping the agitator running.

582. SREEDHARAN NAMBOODIRI (K), VIJAYAN (V) and HRIDAYANATHAN (C)

Development of electro-trawl system in marine environment. *Fish. Technol.*, 14 (1), 1977: 61-65

Electro-trawl system has been successfully tried in UK, West Germany and USA. Efforts were directed towards the development of such a gear system in India which can enhance the catch per unit effort without affecting the quality of the catch.

High voltage pulsed current produced on board a trawler is fed to electrodes distributed along the foot rope of a trawl net through 2 core TRS cable which build up a homogeneous electrical field around the net mouth. By comparative fishing tests with the electrified and non-electrified 32 m. long wing trawl net, the increase in total catch of shrimps and fishes was found to be 19.8% and 36% respectively.

583. CHAKRABORTHY (P K)

Technological development on artificial and solar dehydration of fish in India. *Proc. Indo-Pacif. Fish. Coun.*, 1978.

This paper describes the design of com mercial tunnal dryer operated on electr-icity (or steam) and a pilot solar dryer based on solar energy for dehydration of fish. Estimates of the economics of production of dehydrated fish in both types of dryers have been given. The cost of production in both cases is nearly the same and power cost is insignifi-cant compared to cost of raw materials. Commercial tunnel drying is not very expensive and it can easily replace co-nventional sun drying in India and solar drying may be regarded as an ideal srep for drying fish in tropical fishing villages

584. CHAKRABORTHY (P K)

Small scale project on dehydration of fish. *Syposium on small scale food industry for rural India*, Calcutta, 1978.

In this paper an attempt has been made to clearly point out some important technical aspects on the feasibility of setting updehydration plants under small scale sector. Such units can be set up using technical know-how developed by the Institute. There is good prospect of artificial dehydration of trawler by-catch fishes in India.

585. CHAKRABORTHY (P K)

Modern fish perservation techno-logy for the development of fish-erman society. *Symposium on appropriate technology for rural development*, Quilon, 1978.

In this paper an attempt has been made to illustrate some simple but modern methods of fish preservation which can be adopted by common fishermen under village conditions. For allround develop-ment of fishermen community, some key industries such as ice plant has been suggested.

586. AYYAPPAN PILLAI (S)

Developments in the chilling and freezing on board fishing vessels in India. *XV International Congress of Refrigeration, Venezia*, 1979.

The various methods of chilling and freezing of fish employed on board fish-ing vessels in India have been enumerated. The experiments conducted by Research Institutes and other organisations on the design and developement of refri-gerated sea water plant for small fishing vessels have been described.

587. AYYAPPAN PILLAI (S)

Maintenance of marine engines and accessories of mechanised wooden boats, *Fisherman.*, 1(2), 1980:35-36.

The engine of a boat is rightly descri bed as the heart of the boat because of the vital role it plays in providing necessary power for propelling the boat and other accessories. The positioning and fitting of the parts that contribute towards the basic needs, should be ea-sily accessible for regular and routine maintenance. The author,in this paper, has briefly given an account of the pri-me requirements maintenance of marine engines and accessories of the mechani-sed wooden boats.

588. SREEDHARAN NAMBOODIRI (K) and VELU (M)

Development of an aquatic weed harvester. *First annual workshop*

on *Agri. Engg. and Tech.* in *Kerala*, College of Horticulture Vellanikkara, Trichur, Kerala, 1980.

Aquatic weeds both floating as well as submerged pose a serious problem to agriculture, fisheries, navigation, irrigation etc Removal of weeds by manual and chamical methods is either expensive or poses risk of pollution. This paper describes a mechanical weed harvester developed by the authors by which floating as well as submerged weeds can be successfully removed.

ELECTRONICS AND INSTRUMENTATION

589. RAO (C V N)

Thermistor thermometer for temperature measurement of frozen fish. *Aircond. & Ref.* in India, 5 (4) 1968:24.

A portable self contained temperature measuring unit has been designed for measurement of temperature of frozen fish in the range $-30^{\circ}C$ to $+30^{\circ}C$ with an accuracy of $\pm$ 0.25°C The head thermistor F 23 of Standard Telephones and Cables England, enclosed in a metallic probe forms the temperature sensing element which is included in one arm of a Wheatstones bridge. By careful choice of bridge parameters, the out of balance bridge current is made to change linearly with temperature. The response time constant is less than 2 minutes.

590 SIVADAS (T K)

Simple instrument for measuring depth of operation of fishing gear. *Res. & Ind.*, 13 (2), 1968: 89-90

A simple, light, rugged and direct reading instiument capable of measuring depth of operation of fishing gear up to 25 m. is described With slight modification the depth range can be extended. The instrument is particularly suitable for fishing with small boats.

(This instrument has been later improved to cover larger ranges up to 500 m. along with digital display for higher ccuracies of measurement, salient featatures of which are reported in the CIFT Special Bulletin No.7 compiled by P. J. CECILY).

591. SIVADAS (T K).

Instrument for the measurement of the fore and aft tilt of otter boards. *Fish. Technol.*, 5 (1), 1968 : 27-30

A portable self contained instrument has been designed and developed by the author for measurement of the fore and aft tilt of otter boarbs within the range -22° to $+22^{\circ}$ with an accuracy of $\pm$ 1°. An under water transducer fitted on the otter board converts its tilt into corresponding electrical resistance which is measured in an ohmmeter on board, both being connected by an eletcric cable. The instrument is designed for the rough conditions in sea.

592. RAO (C V N)

Instrumentation in fish processing technology. *Instruments India*, 4(10) 1969:16

This paper reviews instruments available for quality assessment of fish and fishery products, fishing industry and fish processing research.

593. SIVADAS (T K)

Application of ultrasonics in fishing industry and research. I-*Seafood Export* J., 1 (11), 1969:33.

The various properties of ultrasonics have been utilised in research and industry for measurements and precision works. Ultrasonics is a very important technique for underwater measurement as it is the only means of underwater communication. The two common types of sonar methods, viz. active and passsive sonars are discussed with special emphasis on the echo-sounder. The various factors that determine the performance of an active type sonar have been presented in this communication.

594. SIVADAS (T K)

Application of ultrasonics in fishing Industry and research II-*Seafood Export* J., 1 (2), 1969: 35-39.

The author describes the characteristics performance parameters such as, frequency of sonic beam, beam angle, pulse length etc. which are related to accuracy of measurement and echogram interpretation. The uses of echo sounder for fish detection and interpretation are described.

595. SIVADAS (T K)

Instrument for measuring the tilt of otter boards in fishing boats. *Res. & Ind.*, 14 (1), 1969 : 30-31.

The communication describes a simple, light and rugged electronic instrument for measuring the tilt of otter boards continuously throughout the trawl operation

The instrument indicates the tilt of otter boards in a meter on board the vessel in the range of -44° to $+44^{\circ}$ with an accuracy of $\pm 2^{\circ}$ after receiving the signals in the form of variations in electrical resistance from a transducer fitted on the otter board. The cost of the instrument is low when compared to the instruments used currently.

596. SIVADAS (T K)

Improved instrument for measuring the angle of attack of otter boards in fishing boats. *Res. & Ind.*, 14 (1), 1969: 28-29.

An electronic instrument fabricated by the author using indigenously available materials for measuring the angle of attack of otter boards in fishing boats in the range of 0-90° with an accuracy of $\pm 1^{\circ}$ is described. The instrument consists of an underwater transducer and an electronic indicating unit on board the boat, the two being connected by an electric cable. This is a low cost instruments and is free from the drawbacks of the conventional instruments of the type. (This instrument has been later improved for better preformance and reported in CIFT Special Bulletin No. 7.

597. SIVADAS (T K)

Operational depth telemeter for use in fishery practice. *Res. & Ind.*, 14 (3), 1969: 122-125.

An electronic instrument capable of measuring the depth of operation of fishing gear or any other object in the range 0—100m with an accuracy of ±1 m is described. The main components of the instruments are a hydrostatic inductive type pressure transducer and an electronic solid state indicating meter. The range of measurement can be extended considerably (upto 1000 m) by making easy adjustments in the instrument. The advantages of the instrument over those currently in use are light weight, ruggedness and low cost.

598. SIVADAS (T K)

Net depth meters for better fishing. *Seafood Export J.*, 2 (5), 1970: 33-36.

The author describes how a trawl depthmeter can be efficiently utilised for midwater and bottom fishing operations. The instrument provides necessary information about the position of the trawl net and helps the skipper to control the midwater trawl net to the depth where fish shoals are detected It also helps in estimating the correct scope ratio needed for different types of nets.

599. SIVADAS (T K)

Sonobuoys and oceanographic buoys in fishing practice. *Seafood Export J.*, 2 (10), 1970: 29-31.

The success of large scale commercial fishing depends to a great extent on the current knowledge of the potential fishing grounds available for exploitation. The author mentions here the latest techniques that are being adopted in advanced countries for quick survey of the fishing grounds. Sonobuoy is a surface floating buoy with equipments for detecting the fishes using the principle of either active or passive sonar. Oceanographic buoy is a sub-surface buoy with oceanographic sensors for measuring the ocean parameters.

600. SIVADAS (T K)

Underwater warp tension meter. *Fish. Technol.*, 7 (1), 1970: 48-51.

A simple, inexpensive, rugged type underwater electronic warp tension meter developed by the author is described in this paper. The instrument consists of an underwater tension sensor and an electronic display meter on board the vessel botn being connected by a 2 core PVC cable. The instrument measures the resistance to motion of the net, the otter boards and the warp independently with appropriate mounting of the transducer. The transducer is very small and rugged weighing less than 2 kg. The meter measures tension up to 500 kg with an accuracy of ± 5 kg.

601. SIVADAS (T K)

Instrumentation in fishing gear research. *Fish. Technol.*, 7 (2), 1970 : 105–115.

The author reviews the various instruments used for research and development in fishing gear technology. Basically the instruments belong to underwater recording and remote display types. The comparative advantages and disadvantages of different types are mentioned along with brief descriptions as to how the relevant information helps gear research. About a dozen such instruments developed by the author are also described.

(Most of the instruments described in this paper have been later improved incorporating the lastest state of art for better performance and reported in CIFT. Special Bulletin No. 7.

602. SIVADAS (T K)

Acoustic instruments for the study of the reaction of fishes. *Fish. Technol.*, 7 (2), 1970: 211-213.

Two types of acoustic instruments developed by the author for studies on the reaction of fishes are described in this communication. One is an electrical horn producing intense sound under water, while the other is an electronic device which produces sound waves whose frequency can be varied from 20 Hz. to 8 KHz. The amplitude of the wave can also be varied from minimum to maximum.

603. RAO (C V N)

Physics in fish processing technology. *Fish. Technol.*, 8(1), 1971: 1-6.

The impact of physics in fish processing technology can be seen in the development of sophisticated techniques/instrumentations needed for research like chromatography in biochemistry, intellectron fish tester V based on the dielectric behaviour of fish tissue, physical techniques employing nuclear magnetic resonance and molecular absorption properties of water molecular (or hydrogen atom) as a measure of moisture in fishery products, electron microscopy for identification of bacteria and studying the ultra-structure of fish muscle etc. Many a technique in fish processing technology whether it applies to freezing, dehydration or canning and information on physical values like dielectric constant and dielectric loss in the design of quick thawers are based on these principles.

604. SIVADAS (T K)

Underwater observation of the trawl net. *Seafood Export J.*, 3 (4), 1971: 23-25.

The author describes the importance of underwater observations on trawl nets for the purpose of research, standardisation and performance assessment. The basic methods available at present are direct observation by diving, underwater photography, underwater recording type instruments and application of telemetering type instruments. The comparative features of these different systems are mentioned in this paper.

605. SIVADAS (T K)

Instruments and data acquisition systems for research on trawl nets. *Fish. Technol.*, 8 (2), 1971: 124-127.

The progress made in the development of telemetering instruments is reviewed with particular reference to continuous data acquisition systems.

Electronic telemetering instruments have proved to be the primary requisite for the study of the hydrodynamic parameters of the fishing gear. For an effective study and development of more efficient fishing gears, the field of instrumentation has to be further extended with a view to feeding the information to the modern high speed computors for speedy and accurate analysis

of the data. As in other fields of physical sciences there are possibilities of studying the basic properties and parameters of the fishing gear and developing the same with the help of electronic instrumentation controls and data processing.

606. SIVADAS (T K)

Instrument for the measuremant of the variations in mesh shapes of fishing nets during operation. *Res. & Ind*, 16 (3), 1971 : 204-207.

A solid state electronic portable instrument developed by the author for measurement of the variations in the dimensions of the meshes of fishing nets during operation is described in this communication.

The instrument consists of an inductive linear transducer and an indicating meter kept on board the vessel, both being connected by an electric cable. The accuracy of measurement is $\pm$ 2 mm.

607. SIVADAS (T K)

Electronic equipment for safety and efficiency in trawl fishing. *Seafood Export J.*, 4 (2), 1972: 13-17.

The author describes some of the electronic instruments which can be used effectively for better safety and efficiency during trawl fishing. The trawl depth meter and echo sounder enable the operator to shoot the net to the depth where fish shoals are detected. The portable warp load meter and ship-installed warp load meter ensure better safety and proper operation of the under water otter trawl systems in smaller vessels and large vessels respectively. The electronic speed log is a general equipment of routine measurements of the speed of the vessel.

608. SIVADAS (T K)

Indigenous development of electronic measuring and control instrument for fishing industry and allied fields. *Instrument Society of India, Souv. Seminar on growth of Instrumentation in India*, 1973.

Central Institute of Fisheries Technology is engaged in the development of measuring and control instruments for fishing industry and allied fields. Some such instruments are, instruments for commercial fishing, telemetering instruments for testing and standardisation of the fishing gear and its components, telemetering instruments for environmental measurements, instruments for behaviour studies of marine animals and instruments for automation in fish processing factories.

Though the instruments described are not manufactured commercially in the country at present, they have been made available to consumers on a limited scale.

609. SIVADAS (T K)

Recent improvements in sonar fish finding equipments for higher efficiency and performance. *Seafood Export J*, 5 (3), 1973 : 21-26.

Fishing industry is progressing from trial and error to an advanced technology and electronics have contributed considerably at all stages. Modern electronic circuits and components have made active sonar, a really essential and worthy device for efficient and effective fishing. The limits of white line, the grey line, horizontal manual scanning, auto-metre scanning and PPI display, continuous CRT display, bottom expansion, T. V. G. for better identification of echoes, recording threshold

for removing the unwanted signals, echo integrator/counter etc. are explained. It is concluded that in spite of the remarkable progress achieved in sonar devices, telemetry, aerial observation and remote data acquisition in sea are still in less developed stages compared to those in land and space.

610. SIVADAS (T K)

New regulations of marine radio: 1973 onwards. *Sea food Export J.*, 5 (6), 1973 : 35-37.

The world Administrative Conference held in 1967 has decided to make certain important regulations in the use of the types of marine radio transmissions from 1973 onwards which are discussed. S. S. B. transmitters have got several advantages. The required band width is reduced to less than half from that of D. S. B. This enables doubling the number of stations in a limited band thereby solving the problem of interference caused by increased number of transmissions to a considerable extent. The second advantage is the reduced radiated power for the same range of transmission. With the same energy as that of D. S B., S. S. B. transmissions will be about 3 times more powerful. The third advantage is increased signal to noise ratio in reception. It has been decided that all existing D. S. B. equipmet should be replaced by S. S. B. from 1980 onwards.

611. ANNAMMA (T T) and RAO (C V N)

studies on thermal diffusivity and couductivity of fresh and dry fish. *Fish. Technol.*, 11 (1), 1974: 28-33.

The paper deals with the thermal diffusivity and conductivity of mackerel and sardine in relation to their moisture contents and packing densities. Regular regine method (Acalorimeter) for diffusivity measurements and transient line source technique for conductivity determinations were chosen as they were found to be rapid, sufficiently accurate and cause minimum thermal damage of the sample.

612. RAO (C V N) and PRABHU (P V)

On the measurement of concentration of blanching brine by electrical conductivity method. *Fish. Technol.*, 11 (1), 1974: 75–78.

A suitable device for on the spot measurement of salt content of blanch liquors was developed and the results of studies undertaken are incorporated.

The instrument is calibrated in the salt concentration range 5 to 12% containing 02.% citric acid at $98^{0} \pm 2^{0}$C taking into consideration the conductivity errors caused by the proteins leached from prawns into the blanch liquors. It could be seen that a drop of 5°C in the blanch liquor corresponds to a maximum error of 0.3% in the concentration at 9% level on the calibrated scale which is not high for routine measurements. The mean error read by the meter is within 0.4% on the average of the calibrated scale at 7% level due to proteins leached out from the prawns.

613. SIVADAS (T K)

Electronic instruments for fishery industry and research developed in CIFT. *Fish. & Sea Wealth.*, 1 (1). 1974: 38.

The uses of the newly developed electronic instruments for research and investigations

are described in this paper. The importance of monitoring the performance of under water trawl gear system during commercial fishing and equipments required for the same are discussed. The modern methods of investigations on the assessment and further improvements on the behaviour of underwater fishing gear using electronic telemetering instruments are briefly mentioned.

614. SIVADAS (T K)

Portable electronic warp load meter. *Fish. Technol.*, 15 (1), 1978: 69-70.

A portable type warp load meter has been developed for use in fish trawlers. It monitors the warp load in fish trawlers accurately and easily without disturbing the routine fishing operations and can be used in several other places like cranes, bollard tests for marine engines, dry docks etc., especially when the operation has to be conducted easily without disturbing the load system. The information displayed in a micro-ammeter in the range 0 to 1000 kg can be fed to continuous recorders for detailed analysis and permanent records.

615. SIVADAS (T K)

In situ temperature and salinity meter. *Fish. Technol.*, 15 (1), 1978 : 77-80.

The author describes an electronic instrument for remote measurement of temperature and salinity using platinum electrode sensing probe and a simple and novel electronic circuit. Instant and remote measurements of temperature and salinity of sea and estuarine waters are possible with the instrument. Temperature compensations for salinity measurements are done manually with the help of temperature charts. The temperature and salinity measurements can be fed to continuous recorders.

(This instrument has later been improved incorporating the simultaneous measurement of depth also for better accuracy and higher ranges along with digital display.)

616. SIVADAS (T K)

Indigenously developed, marine electronic instruments. *Industrial Fisheries Ass., University of Cochin*, Cochin, 1979: 31-39.

Electronics and Instrumentation have made remarkable contributions in the various disciplines connected with Industrial fisheries as well as research and development associated with it. The author briefly describes some of the marine electronic instruments developed in CIFT viz. warp load meter for safety and efficiency in trawl fishing, trawl depth meter for aimed trawling, electronic boat log for monitoring the towing speed, catch telemeter for instantaneous measurement of catch in net, electronic instruments for fishery hydrographic investigations, such as temperature and salinity meter, water current meter, testing and standardisation of underwater trawl systems, underwater line tension meter, board tilt meter, mesh distortion telemeter, bollard pull monitor, freezer temperature monitor and alarm, brine concentration meter, automatic brine dispenser, moisture meter, fish activity recorder and barnacle cirri automatic counter. These instruments were developed for use in commercial pre-harvest and post-harvest fishery technology, facilitating various R & D programmes for yielding better scientific results.

617. SIVADAS (T K)

Electronic testing and measuring instruments developed in CIFT for mechanised fishing vessels. *Seminar on Mechanised Fishing*, All Kerala *Federation of Mechanized* Fishing Boat Owner's Ass., Cochin, 1980.

The various electronic instruments developed in CIFT for effective mechanised fishing operation are described. The use of warp load meters for efficiency and safety during trawling, trawl depth meter for aimed trawling, electronic boat log for monitoring the towing speed, catch telemeter for instantaneous measurement of catch in the net, bollard pull monitor for testing the engine capacity, marine temperature alarm for safety of the vessel against misalignment of the engine,bilge water alarm for timely warning against bilge water leakage etc., are briefly described. A set of telemetering type testing instruments for monitoring and assessing the performance of trawl system is also mentioned.

618. SIVADAS (T K)

Indigenously developed electronic instruments for fishery technological investigations. *All India Seminar on Agricultural Implements, Kerala Agricultural University, Vellanikkara*, 1980.

The author briefly describes how the various electronic instruments developed in CIFT could be utilised for strengthening the studies and investigations in fishery technology. While emphasising the need for better inter-institutional collaboration for proper utilisation of the indigenously developed technologies and findings, the author mentions certain instruments such as moisture meter, freezer temperature indicator and alarm, bollard pull monitor etc., which could be used for other agricultural investigations. The moisture meter primarily developed for measurements in dry fishes can be used for moisture measurements in wood, honey, copra, food grains etc. The freezer temperature indicator and alarm which was primarily developed for remote measurement of the temperatures of cold storages, can be used for standardising the temperature at several points inside the sugar cane stalks and inside the heat therapy chamber. The bollard pull monitor which was developed for monitoring the bollard pull of boats, can be used for measuring the loads developed by different types of agricultural implements.

619. SIVADAS (T K)

Marine electronic instruments developed in CIFT. The convention and exhibition organised by Institute of Electrical and Electronic Engineers, Trivandrum, 1980.

The author describes how the state of art in modern electronics and instrumentation could be utilised for designing the required marine electronic instrument for fishery technological and other related marine investigations. The various fields where these developments could be applied are fishery hydrographic and oceanographic investigations, commercial testing, testing and standardisation of underwater trawl systems, behaviour studies of marine animals, quality control and automation in fish processing factories.

The specific instrumentation problem relevant to marine activities are mentioned here.

STATISTICS

620. BANERJI (S K) and KRISHNA RAO (K)

On a rational criterion for assigning batch numbers to processed products of shrimp. *Fish. Technol.*, 1 (2), 1964 : 171–175.

Investigations were conducted to find out the variability of processed shrimp with respect to two quality characteristics namely, the number of deteriorated and discoloured pieces. Samples of 50 pieces of shrimp of different size grades were collected for three days from two factories at Cochin at the pre-freezing stage.

Both the quality characteristics were found to be significantly different size-grades and one characteristic over different days in both the factories. The interaction term with respect to both the characteristics was found to be significant in one of the factories. The imperfect way of sorting out shrimp into different size grades was ascribed as the probable reason for this.

621. KRISHNA IYER (H), KAIMAL (P N R) and PILLAI (V K)

Sampling of frozen prawns for becteriological estimation. *Fish. Technol.*, 1 (2), 1964: 168-170.

Peeled and deveined prawns were quick frozen in a plate freezer at – 40°C. Difference between samples taken from the surface and interior of the frozen block with respect to bacterial count was studied. Random samples of different quantity groups weighing about 6-11g, 11–16g, 16-21g, 21-26g and 26-31g were drawn from the block. The hypothesis set up for the purpose was that the surface and interior samples were random samples drawn from the same population having the same bacterial load.

The minimum quantity required to represent a 1300 g block was 21–26g. The results indicate that at 5% level of significance the surface and interior samples do not differ significantly.

622. KRISHNA RAO (K) and PILLAI (V K)

Study on the assessment of quality in the preshipment inspection of frozen prawns. *All India Conference on Quality Control, Madras*, 1967.

The data relating to the percentage of defective pieces of two categories for two different types of frozen prawns were observed to spread over different ranges for each member. The sum of frequencies under each category above a particular percentage of the defective pieces was small. Particularly the number of observations recorded by each inspection member beyond the limit were rejections could be caused, were noticed to be small. By statistical analysis the proportions of such cases were found to be uniform over all the ten members of the inspection staff. It is concluded that though differences exist in evaluation of the quality of the product, rejections caused by the staff could not be considered as either high or low due to any particular member of the inspe-

ction staff, because of the low percentage of rejections taking place in the product in general.

623. KRISHNA IYER (H), RAJENDRAN (R) and CHOUDHURY (R L Roy)

Comparative fishing ability and economic efficiency of mechanised trawlers operating along the Kerala Coast. *Fish. Technol.*, 5 (2), 1968: 71-80.

The study was undertaken with a view to finding out the comparative fishing ability and economic performance of fishing vessels of sizes, 9.15 m, 9.76m and 10.97 m designed by CIFT and operated along the Kerala coast for 4 consecutive fishing seasons from 1964-65 to 1967-68. The catch/ unit effort and total effort year for the 10.97 m vessels were much better than those for 9.76 m vessels. The yearly landings and the crew remuneration for the former were about twice those of the latter. The economic efficiency of the 10.97 m vessels was also much better. The decline in landings/year in both size groups was more due to the reduction in the effort/year than the decline in catch/unit effort.

624. PILLAI (V K) and KRISHNA RAO (K)

Pre-shipment inspection and quality control of fishery products in India. *Technical Conf. on Fish Inspection and Quality Control, Canada*, 1969.

The main principles governing the pre-shipment inspection programme for canned and frozen shrimps and frozen frog-legs in India are reviewed. Inspection centres have been established in all important production and shipping areas in the country. Over 3700 inspections are carried out annually, which cover approximately 12000 tons of frozen shrimp, 1700 tons of canned shrimp and 700 tons of frozen frog-legs. Inspection is based on organoleptic and physical characteristics. Canned and cooked frozen shrimp are also subjected to bacteriological examination. Sampling procedures take into consideration the quality variation between different size groups, types of pack and days of production. The sampling and scoring procedures are rigid to reduce the possibility of an accepted lot being rejected by the importing country to a minimum

625. KRISHNA IYER (H) and PILLAI (V K)

Sensory evaluation of quality with special reference to fishery products. *Workshop on sensory evaluation of foods, CFTRI.*, Mysore, 1971.

The paper deals with different statistical methods used in the sensory evaluation of quality of foods, especially those of fishery products. It also describes in detail as to how a taste panel can be constituted by making use of solution of Sodium chloride, Hydrochloric acid, Sucrose, Sodium carbonate and Quinine sulphate to represent the basic tastes of saltiness, acidity (sourness), sweetness, alkalinity and bitterness respectively.

626. KRISHNA RAO (K)

Control of drained weights in frozen prawns. *Fish. Technol.*, 8(1), 1971 : 104-105.

The control of drained weights of blocks during production is handicapped due to the destructive nature of the procedure involved and the time consumed for the determination of the drained weights. In canned

prawns it was noticed that the significant correlation existing between gross weight and drained weight could be of help in controlling the latter by adopting statistical quality control charts for the former during production. In frozen prawns also similar correlations are observed among the different variables.

The correlations obtained are highly significant which points out that gross weight of a frozen block can be considered as a correlated factor to indicate significant variation in drained weight. Any change in processing variables which, if not rectified in time, may lead to erratic drained weights ultimately can be expected to reflect in the gross weights. Control charts for gross weights will be immensely useful in tracing such variations.

627. KRISHNA RAO (K)

Control charts : An application in shrimp canning. *Fish. Technol.*, 8 (2), 1971 : 120-124.

In this article, the procedure for setting up a variable control chart is described with observations taken on filling operation of cans in a shrimp canning factory.

A comprehensive description of the procedure for different kinds of control charts, the kinds of action to be taken under different conditions and the adjustments necessary in the filling process to suit the minimum specified fill-weight are dealt with.

Application of control charts to filling performance in particular has led to good deal of savings of material in many industries. The application of control chart, however, need not be restricted to the filling performance only. It can be applied at different stages of processing, chosen with discretion, to get an end product of uniform quality.

628. KRISHNA RAO (K) and PILLAI (V K)

Quality evaluation of frozen prawns: A case for revising conformity criteria. *ISI Bull.*, 23 (1), 1971: 20-23.

The communication is based on a study of some of the factors in the actual preshipment inspection data. Analysis of the data on frozen prawn has shown that the specification for frozen prawns IS : 2237 – 1962 needs revision, giving importance to the relevant quality characteristics for the different types of packs. Alternative tolerance limits which may replace the present scoring system are suggested for the headless shell-on, and peeled and deveined prawns. A case for revision of the sampling plans is also made out.

629. KRISHNA IYER (H)

Methods of sensory evaluation of quality and application of statistical methods in sensory evaluation problems with special reference to fishery products. *Fish. Technol.*, 9 (2), 1972 : 104-108.

Sensory evaluation is still the most reliable method for evaluation of the freshness of raw and processed fishery products. Quite a good number of tests are used in sensory evaluation of qualities of foods and beverages. These tests are broadly classified under 4 heads, as difference tests, preference tests, descriptive tests and sensitivity tests,

Depending upon the type of problem on hand, a particular method can be selected. Since sensory evaluation methods are to a great extent psycho-physical in nature, statistical methods are quite often used in the design analysis and interpretation of data pertaining to experiments on sensory evaluation of foods and beverages. Numerical scoring system was frequently used for evaluating or rating the quality of fishery products.

630. KRISHNA RAO (K)

On control of drained weights in some fishery products. *Fish. Technol.*, 9 (1), 1972 : 1-4.

Canned and frozen prawns are subjected to compulsory preshipment inspection during which compliance of the products with their declared drained weights is verified. The material used in the processing of these products being biological in origin, the drained weights are susceptible to variation due to a number of factors. Since determination of the drained weights involves destructive and time consuming procedures, application of control chart for drained weights on the processing line is not possible.

The gross weights of the products are significantly correlated with their drained weights and since the determination of the former does not have the disadvantage of determination of the latter, the drained weights can be controlled through the application of control chart for the gross weights.

631. KRISHNA RAO (K) and GOPALAKRISHNAN NAIR (R)

Prices of Indian frozen shrimp in U. S. market : A note on seasonal variation. *Fish. Technol.*, 9 (2), 1972 : 182-184.

To understand how seasonal variation is reflected in the prices of the Indian frozen shrimp in U. S. market, corresponding indices for January through December were worked out for the size grades of 16/20, 31/35, 71/90 and 130 up of peeled and deveined shrimp and 26/30 of headless shell on shrimp and the results are presented in this communication.

The data considered here pertain to the six year period of 1966-71 which was treated as equal to 100. The variation between the maximum and minimum indices for the Indian shrimp is around 8% in all size grades of peeled and deveined variety and about 10% in the case of 26/30 headless shell on variety, as compared to the indices of the U. S. domestic production, which show less than 3%. The price variation during any particular year may be high, but the indices show less variation as they are based on the entire period.

632. GOPALAKRISHNA IYER (T S), MATHEW (Annamma), JOSEPH (A C), KRISHNA RAO (K) and PILLAI (V K)

Faecal streptococci in fresh frozen shrimp. *Fish. Technol.*, 10 (1), 1973 : 66-70.

Many treatments tried to reduce the high numbers of streptococci in the raw prawns did not turn out to be successful. A survey was conducted to ascertain how far the factories will be in a position to comply with the requirements prescribed in the present standard. The results of the survey are presented in this communication.

Present limit of faecal streptococci as 100/g in fresh frozen shrimp was found

to be too strict a standard for commercially prepared products. Fixing the maximum permissible limit as 1000/g will be a more workable proposition.

633. KRISHNA RAO (K) and GOPALAKRISHNAN NAIR (R)

Indian frozen shrimp in U. S. A.: A study on movement of prices. *Ind. J. Agril Eco.*, 28 (3), 1973.

A study was carried out to find out as to what extent the variations in prices of Indian shrimp in the U.S market can be attributed to those of shrimp from domestic landings. The results are presented in this paper.

The analysis shows that the price movement of Indian frozen shrimp is significantly related to local shrimp in U. S. A, the extent of relationship varying with the different size grades. As the multiple regressions show that a high percentage of variation in Indian frozen shrimp is explained by the prices of Brownsville shrimp, it is possible that the same factors mentioned play a major role in determining the prices of Indian shrimp also.

634. UNNITHAN (G Rajagopalan), SREENIVASA RAO (P) and KRISHNA IYER (H)

Study on the average yield of of different species of prawns used for freezing and canning. *Fish. Technol.*, 12(1), 1975 : 25–30.

The paper deals with the average yield of four species of prawns viz., *Metapenaeus dobsoni*, *Metapenaaus affinis*, *Parapenaeopsis stylifera* and *Penaeus indicus* on conversion to peeled and deveined (PD), cooked and peeled (CP) and headless shell on (HL) forms in the different months of a year and the variations observed in the same.

635. UNNITHAN (G R), KRISHNA IYER (H) and KRISHNA RAO (K)

Statistical study on weight loss in frozen prawns. *Fish. Technol.*, 13 (2) , 1976 : 133-138.

This paper deals with an extensive study conducted to estimate the extent of weight loss in frozen prawns. The weight loss varied from 7 to 12% in peeled and deveined, 5 to 7% in headless and about 7% in cooked and peeled prawns from the date of processing to the date of inspection, normally within two weeks. To compensate the weight loss, nearly 11% of excess material is being added to every block resulting in an average annual loss of Rs. 2.68 crores in foreign exchange. The relevant data pertaining to the period 1971 to 1973 and the annual average loss were estimated for ten years ending 1973.

636. UNNITHAN (G R) and KRISHNA RAO (K)

On performances at various stages in the shrimp processing factories. *Seafood Export J.*, 9(6), 1977 : 9–13

The rates of turn over of work at various stages such as beheading, peeling, sorting, grading, weighing, filling, packing etc., of the material in the shrimp processing factories were investigated. The rates of turn over at different stages of processing vary among the factories.

637. KESAVAN NAIR (A K), SRINIVASA RAO (P), UNNITHAN (G R) and KAIMAL (P N R)

Observations on the wastage of raw material and recovery of meat in the prawn processing industry. *Fish. Technol.*, 16 (1), 1979 1-5.

The study conducted during 1974-77 is meant to arrive at the factors responsible for wastage and the count of whole prawns required for a specified size grade in the prawn processing industry.

The wastage of prawns due to spoilage in processing factories accounted to about 0-12% in 1974, 0-35% in 1975, 0-3% in 1976 and 0-4% in 1977. Spoilage increases with the time lag between catching and processing and also due to defective icing. The paper discusses the counts of whole prawns required for obtaining meat of specified size grades. If the size variability of prawns differs among lots of the same count, it may cause variations in the yield in the same size grades obtained from different lots having the same count. Variation in the rates of recovery among the same species was found to be caused by the differences in the method of peeling.

SURVEY AND EXTENSION

638. BALASUBRAMANYAN (R)

On the popularity of some net fishing in India. *Symposium on improved types on fishing from small mechanised boats. Cent. Fish. Techn. Res. Station*, Cochin, 1958.

The paper describes certain points to improve the efficiency of gill nets.

639. PILLAI (V K)

Production and use of edible fish meal. *Pragti*. 8(6), 1959 : 164.

This paper describes method of production of fish meal which can be used for human consumption.

640. VENKATARAMAN (R) and BEATTY (S A)

Role of the technological laboratory in the rapid development of the fish processing industry in India. *Proc. Indo-Pacif. Fish. Coun.*, 9(3), 1961 : 89-94.

The problems pertaining to fresh and the need for suitable processing plants at important fresh fish distribution centres are discussed. The main purpose of a technological laboratory is to solve the technical problems of the artisanal fishermen and fishing industry so as to enable them to get maximum return for the raw materials harvested from the sea and inland resources. Industries based on byproducts and utilisation of waste have to be strengthened, for which the role of extension work for the rapid propagation of the findings made in technological laboratory is important.

641. DESHPANDE (S D) and GEORGE (N A)

Effect of extra buoyancy of floats on the catches landed by a 55' shrimp otter trawl. *Symposium on prawn fisheries in India, Cochin*, 1964.

The paper details on the catches landed by a 55' otter trawl net with varying buoyancy on the head rope. The buoyancy required for this particular design is given based on the results.

642. GOVINDAN (T K)

Indian prawns and their commercial processing. *Sci. Rep.*, 12(2), 1965 : 556-559.

The important commercial species of prawns caught in India are, *Penaeus indicus, Metapenaeus dobsoni, Metapenaeus affinis, Metapenaeus monoceras, Para peneopis stylifera, Penaeus carinatus* or *Penaeus monodon* and *Palaemon carcinus*. Dry prawn pulp was India's only commercial processed prawn product until a decade back. Frozen prawns retain almost all the properties of the fresh material. In commercial practice prawns are frozen in various types viz ; raw headless fresh frozen, peeled and deveined fresh frozen butterfly or fan-tail, cooked peeled or peeled cooked and peeled and deveined cooked. Canning of prawns is also of very recent origin. In this method, a thorough cleaning of the prawns is carried out by removing the shell particles, vein bits and other extraneous matter, if any, before processing.

643. KURIYAN (G K)

Trends in development in the prawns fishing technique in India : A review. *Fish. Technol.*, 2(1), 1965 : 64-68.

The indigenous gear for prawns are the filtering type nets like the stake nets, boat seines and beach seines. Prawns have also been reported from the catches of gill nets and cast nets. Dredges and beam trawls are simplest among the dragged gear. The experiments conducted to evaluate the effectiveness of fully mechanised and partially mechanised operation, the effect of extra buoyancy of floats and the use of tickler chain in enhancing the prawn catch are described in detail.

644. BOSE (A N)

Fishery industry : Processing and standardisation. 10th *ISI Convention Souv.*, 1966 : 211.

The various methods of processing fishery products and standardisation of their quality are described.

645. BOSE (A N)

Quality control in marine products. *Foreign Trade of India*, Dec. 1966-Jan. 1967 : 71.

The importance of quality control measures in marine products is stressed with illustration.

646. PILLAI (V K)

Recent developement in fish processing and preservation. *Fish Technol.*, 3(2), 1966: 90-93.

The author gives a brief account of the revolutionary changes that have taken place in the methods of preservation and processing of fishery products. Extracts, from natural vagetable material have been found to possess very good antioxidant properties. Experiments carried out on shell fish like lobster and

crabs have shown normal pasteurization procedures to be very effective in arresting deteriorative changes during long storage. The most important development in the field of fish processing is the discovery of accelerated freeze drying technique. In the field of canning the conventional batch type thermal process using still or agitating retorts are giving place to more efficient methods. In the field of freezing of fish, recent studies have shown that an initial dip in a solution of polyphosphate salts yields better quality products.

647. BOSE (A N)

Research in fishing craft and gear at Central Institute of Fisheries Technology. *Seafood Trade J.* 2(1), 1967 : 89 - 95.

Designs of longer boats made of wood or steel and also of boats for specific types of fishing have been undertaken at CIFT. Experiments carried out have shown that Venteak which is at present only one third as costly as Aiyani can successfully replace it for boat building. Experiments have also lead to a composition of aluminium alloy to be used in sheating, the correct painting schedule including use of antifouling paints for the aluminium sheathing and arrangments for the electrochemical protection of the sheathing.

648. BOSE (A N)

More fish for better food. *Sci. Rep.*, 3(12), 1967 : 568.

The author emphasizes the need for employing scientific methods of fishing for increasing the fish catches of the country so as to augment our food resources.

649. GOVINDAN (T K)

Salience of sardine. *Sci. Rep.*, 4(12), 1967 : 562-564.

The oil sardine, (*Sardinella longiceps*), an important fish, found in Indian coastal waters, is a rich source of protein and industrial oil. Recent research in our country has shown that sardine oil can be used in the leather industry, for preparing fat liquors for leather dressing, in metallurgical industry for tempering of steel, in rubber industry for preparing factice-an artificial filling material for rubber, in the printing ink industry as an ink base, for conversion into lubricating oil for various industrial purposes and in the paint industry The sardine, in combination with tapioca which is also very cheap, constitutes a near perfect food with high protein, fat and carbohydrate contents. A sizeable proportion of the sardines is canned in India. The oil sardine is seldom dry cured because the high fat content, which is rich in unsaturated acids, gets oxidised on drying. Addition of praservative chemicals like sodium benzoate or sodium propionate in low concentrations in the pickling brine keeps the fish in good condition for good length of time, even for an year.

650. GOVINDAN (T K)

Some common defects in prawn processing : Their sources and remedies. *Seafood Exporter.*, 2(9), 1968 : 9-17.

Some of the important points to be observed to maintain high standards of quality of prawn products are enumerated in this paper. Fresh prawns must be iced as early as possible after catch and beheading must be done as quickly as possible. Instances of bacterial loads

of the order of 10^6 per gram with considerable numbers of pathogenic organisms in the ice have been encountered. This could be avoided by chlorinating the water prior to freezing and careful handling after freezing. The presence of foreign material in the finished product reduces its score in quality assessment. Slow freezing lowers the organoleptic quality of the material. The time taken for freezing is usually 2 to 3 hrs. in the contact freezer and 4 to 5 hours in the tunnel freezer. The importance of personal hygiene as well as factory hygiene has been stressed for turning out products of high standards.

651. GOVINDAN (T K)

Application of technology in optimum utilisation of the fishery resources of India. *Proc. of the Symposium on living resources of the sea Around India*, Cochin, 1968.

The paper deals with some of the recent achievements made towards finding out ways and means of proper handling, transportation, preservation by different methods of processing, economic utilisation of the byproducts and equitable distribution of our fishery products. Procedures for preservation of our important food fishes and shell fishes by freezing, canning and dehydration including curing have been summarised. Salient features of utilisation of fish body and liver oils for industrial and pharmaceutical purposes, conversion of cheap varieties of trash fish into fish protein concentrate for human consumption, bacteriological peptone and speciality products like fish flakes, soup powder, fish pastes, etc. and economic usage of wastes from processing factories for fish meal and isolation of valuable chemical compounds have been detailed in this communication.

652. KAIMAL (P N R)

Scope of extension in fishery technological research. *Souv. Fish Exporters Chamber*, Tuticorin, 1968: 75-81.

For the economic developments of a country through the application of technological research, the gap between research findings and their application in the industry should be reduced to the minimum. Extension is therefore a necessity and stands with equal importance as research itself. It can function to locate problems actually faced by the fisherman or the fishing industrialists on the one side and feed the matter to the research institute on the other. It can also act as a liason in disseminating the knowledge of research findings back to the industry so as to equip them for getting better returns for their efforts. The extension activities should be carried out by actual contact with the fishery interests as well as through common media of propagation like radio talks, distribution of pamphlets concerning research findings in local languages and through newspapers.

653. KURIYAN (G K)

Role of gear in estimation of the living resources. *Symposium on Living Resources of the Seas around India*, Cochin, 1968.

The principle of exploitation of living resources by judicial selection of fishing gear is highlighted in this paper.

654. KURIYAN (G K)

Fishing gear research at the central Institute of Fisheries Technology. *Fish. Technol.*, 5(1), 1968 : 1-4.

The craft and gear wing of the CIFT was established in the year 1957 as a part of the fisheries development schemes to develop the country's fishing boats and implements scientifically and systematically. Gear research work is conducted under two principal sections namely Materials section and Gear design and fishing methods section. The author has highlighted the fishing gear research of the C I F T, in this paper.

655. RAJENDRAN (R) and CHOUDHURY (R L Roy)

Study of the sea state data collected from Bay of Bengal during 1964-65. *Fish. Technol.*, 5 (1) 1968: 21-26.

The wave data collected on board INS KISTNA from bay of Bengal during July to August, 1964 and January, February and April, 1965 are presented. The wave parameters were analysed and given in a form most suitable for model testing of ships The variation of wave height with beaufort number is remarkable. Wave periods from 2 to 10 seconds were observed with maximum frequency in the range of 2 to 5 seconds. The heights and periods obtained are compared with those obtained by previous workers for the North Atlantic region and Bay of Bengal. The influence of wave periods of 2 to 5 seconds on the rolling, pitching and heaving periods of medium size vessel is also discussed.

656. GOVINDAN (T K)

Bombay duck. *Sci. Rep.*, 6 (3), 1969: 143 - 144.

Scientifically called *Harpodon nehereus*, Bombay duck constitutes an important fishery of our country. A Remarkable feature about this fish is its chemical composition, i. e. it has got a moisture content of 90% the highest recorded for Indian fishes, Modern methods of preservation like freezing and canning have not yet been tried on Bombay duck. To date the most important method of preservation employed is sun-drying. The fresh fish can be preserved in crushed ice in satisfactory condition for about a week, Recently, preservation by irradiation has been tried on fresh Bombay duck.

657. GOVINDAN (T K)

Fisheries Technological Research in India. *Seafood Export J.*, 1(3) 1969 : 15 - 20.

The research problems handled at CIFT and the progress achieved have been enumerated. The Institute has made design drawings of different sizes of boats with different powered engines, constructed their prototypes and has contributed a lot to the mechanised fishing in our country by making available the drawings and other details of the technical know-how to State Governments and private boat buildings yards. Various designs of nets suitable for different localities and types of fishes have been evolved and technical help was rendered for popularisation of these nets among fishery entrepreneurs.

658. GOVINDAN (T K)

Fish and the nation. *Seafood Export J.*, 1(7), 1969 : 19 - 23.

The contribution of fish to India's economy is exemplified by the fact that the annual fish landings in India has reached the figure of 1.3 million metric tonnes and the earnings of foreign exchange by exporting fishery products have exceeded Rs. 20 crores per annum. A survey of the development of this vital industry reveals two distinct phases in

the process viz. the one of stunted growth in the hereditary way upto the year 1953 and the 2nd phase that followed with rapid mechanisation of fishing operations, application of modern preservation methods and export of frozen and canned fishery products to other countries.

659. GOVINDAN (T K)

Frogs fetch foreign exchange. *Sea food Export J.*, 1(8), 1969 : 29-32

Processing and export of frog legs from India commenced only from the latter half of 1959 and phenomenal progress has been achieved from then onwards. The common varieties of frogs caught in our country are the bull frog (*Rana tigrina*) and *R. hexadectyla*. Only the pair of hind legs from the frog is used by the freezing industry, the rest of the body which contains comparatively little edible flesh being wasted. The ISI has formulated quality standards for this product.

660. GOVINDAN (T K)

Government policies and their effect on the development of fishing and fish processing industries in India. *All India Seminar on food Industry, New Delhi*, 1969 : 54 - 58.

An outline of the impact of the measures taken by the Government on the present state of development of the industry is described. For properly exploiting the vast hidden resources of our surrounding seas for economic benefit of the nation, exploratory fishing with mechanised vessels was introduced by the Goverment of India through the Offshore Fishing Station and Indo-Norwegian Project. Organised fisheries research in the correct sense of the term was initiated in the country only with the establishment of Institutes like, CMFRI, Mandapam, CIFRI, Barrackpore, CIFT, Cochin, CFTRI, Mysore. The introduction of preshipment inspection of frozen and canned products on a voluntary basis from April 1964 and compulsorily from March 1965 by the Government of India has helped immensely in stepping up our exports and avoiding rejections at the destination ports. Establishment of the Marine Products Export Promotion Council at Cochin in 1961 was another landmark in developemnt of our fishing and fish processing industries.

661. GOVINDAN (T K)

Pink Gold. *Seafood Export J.*, 1(6), 1969 : 25 - 28.

Considering the quantum of valuable foreign exchange earned for the country every year by this commodity 'viz. chemmeen' and that too in hand currency, the title suggested for it by the author appears to be fully justifiable. In this article the author has described its preservation processes, by-products and quality control with special emphasis on the enviable status it enjoys at present.

662. KURIYAN (G K)

Central Institnte of Fisheries Technology. *Indian Seafoods*, 7(3), 1969 : 3 - 6.

Realising the pressing need for co-ordinated research in the various aspects of fisheries technology, the Government of India, Ministry of Food and Agirculture set up CIFT in 1957. The craft and gear division was organised first with the chief objective of undertaking studies on materials for boats and nets, their maintenance and preservation, improved designs of fishing gear, performance of engines and designs of fishing accessories. The

investigations of the Processing Division cover both fundamental and applied aspects of processing technology. Particular emphasis has been laid on problems in dehydration techniques; icing, freezing canning, utilisation of fish wastes and development of different by-products, and designing of essential equipments for the processing industry.

663. KURIYAN (George K)

Society of fisheries technologists (India) *Seafood Export J.*, 1(8), 1969 : 35.

The Society of Fisheries Technologists (India) was organised in 1962. The society conducts scientific meetings, where results of investigations in the different fields of fishery and allied sciences are presented and discussed. The society is publishing a Journal 'Fishery Technology', a half yearly publication.

664. KURIYAN (G K)

New fishing gear and methods required *Indian Farming*, 14 (9), 1969 : 97.

Estimation and evaluation of strength, reduction in strength while made into loops and knots, relation between load and elasticity, fatigue in static and impact loads, sinking speed, abrasion, rotting-its process, causes and prevention, reaction to sunlight, acid, alkali and other chemicals are some of the characteristics which exert a profund influence on the selection of materials, designs and methods of operation of different fishing gear. The requirements on the basis of the above characteristic features for fishing is highlighted in this paper.

665. PILLAI (V K), CHOUDHURI (D R) and GOPALAKRISHNA IYER (T S)

Preparation of bacteriologically sound froglegs. *Res. & Ind*, 14(4), 1969 : 170.

A modified method for the production of bacteriologically sound frozen froglegs has been developed, taking into consideration the existing trade practices in the pre-process preparation of froglegs. The method ensures a bacterial load of less than 10,000/g for all sizes of frogles, with complete absence of coliforms and salmonellae. There is also no change in the organoleptic and physical characteristics of product.

666. PILLAI (V K) and GOVINDAN (T K)

Fish processing industry in India. *Indian Food Packer*, 23(6), 1969:40.

Export figures of canned and frozen fishery products from India from 1953 to 1967 have been presented. Recent export figures for dried fish products indicated a decline and revival of this industry on modern lines seems to be necessary to compete successfully in the sophisticated markets. Chemical treatment has been developed to control the common defects like fungus and red halophilic bacterial attack. Thaw drip loss in frozen prawns can be overcome by polyphosphate treatment of raw meterial and by giving glazing using sodium alginate Dip treatment of fish in CTC followed by storage in ordinary ice has been found effective in prolonging the storage life of fish. Methods have been worked out for freezing food fishes like pomfrets, sardine, mackerel, tunnies lactarius, Bombay duck, caranx, seer, shark, hilsa, catfish, eels etc.

Individual quick freezing after dipping oil sardines in 15% brine for 30 minutes is found to control belly bursting. Methods have been worked out for preparation of sardine oil in pure form. A variety of products like water repellent paints, artificial rubber filling compound called factice, lubricating oil, printing ink etc. can be prepared from sardine oil. The shell and head portion of prawns are found useful in the preparation of chitosan and glucosamine hydrochloride and processes have been worked out for their production. High quality chick feed also can be prepared from the shell wastes. Fish protein concentrate can be prepared from trash fish which can be incorporated in cereal flours, bab foods and tonics. High quality peptone also can be prepared out of trash fishes. Good quality cheap cattle and poultry feed can be developed from trash fish.

667. PILLAI (V K) and GOVINDAN (T K)

Fish processing industry: The potential for its expansion and diversification is immense. *Food Industries* J., 3(4), 1969 : 18 - 22.

The revival of our fish curing industry is one of the most urgent needs of the country not only from the point of view of national economy but also due to the fact that no fishing nation can do away with it which is still the largest and cheapest single method of preservation of fish. Proper distribution of fresh fish in internal markets calls for the establishment of chain of cold storages in all parts of the country. Methods have been evolved for the preservation by freezing of some of our important food fish like pomfret, sardine, mackerel, lactarius, Bombay duck, caranx, seer etc. Another significant finding is the possibility of preparation of high quality peptone from trash fishes. The image of our product in the importing countries is good at the moment especially after the introduction of compulsory preshipment inspection. There is greater confidence among the buyers regarding quality and uniformity of imported Indian products as every shipment is accompained by a certificate issued by the inspection authority in India.

668. GOVINDAN (T K)

Sea cucumbers. *Seafood Export J.*, 2(12), 1970 : 23 - 26

A detailed account of sea cucumbers belonging the family 'Holothuridae', their occurrence' peculiarities and characteristic features are dealt in this communication. The product prepared out of this is called Beach-de-mor or Trepang. Processing under strictly hygeinic conditions without allowing any microbial contamination at any stage, drying to the required moisture and packing in attractively printed polythene bags can ensure a good trade in processed sea cucumbers.

669. GOVINDAN (T K)

Some noteworthy miscellaneous marine fishes of India *Seafood Export* J., 2 (9), 1970: 19-26.

A group of miscellaneous Indian marine fishes namely ribbon fish, anchovies, jew fish, cat fish, silver bellies, lactarius and sole, their occurrence, technology and chemical composition are briefly discussed here. Salt curing and drying appear to be the most suitable method of preservation in our country for these fishes since the more sophisticated methods of freezing and canning increase their cost beyond the

purchasing capacity of the common man.

670. GOVINDAN (T K)

Three highly esteemed table fishes of India. *Seafood Export J.*, 2(5) 1970 : 11 – 15.

Among the several species of our marine fishes, pomfrets, seer and tuna are perhaps the most highly esteemed table fishes both from the point of view of consumer acceptability and nutritive qualities. The single method of preservation used for these fishes even now in our country, remains to be salt curing and drying which is widely applied in times of heavy catches.

671. GOVINDAN (T K)

Vegetarian foods from the sea. *Seafood Export* J., 2(1), 1970 : 113 – 115.

The author discusses the contribution of seaweeds to the economy of our country by earning foreign exchange providing good quality vegetable food additives and other materials for industrial and research purposes. The chemical composition of sea weeds has also been discussed.

672. KAIMAL (P N R)

Role of technological research in fisheries development, *Indo African Trade* J., 6(2), 1970 : 32 – 35.

The progress made by the fishery Industry in India during the past decade has been outstanding. In all the phenomenal development technological research carried out in the country directly or indirectly came to the aid of the industry. With the designing of twelve standard sizes of boats in the range of 7.67M to 15.35M within a comparatively short period, this requirement was met and today most of the mechanised fishing boats operating in the country have been built according to these designs. Several types of mechanised fishing aids, designed and recommended, made it possible to manufacture the items within the country and at present all the deck equipments for small and medium sized boats including steel trawlers are manufactured indigenously. New and improved metnods for better economic utilisation of the fish catch, for uniform distribution of fish within the country and expansion of internal and external trade of fish products are some of the latest innovations in the fisheries industry.

673. VENKATARAMAN (R) and KANDORAN (M K)

Marketing potentialities of some new fishery products. *Seafood Export* J., 2(5), 1970 : 29–31.

The aim of this article is to stress the importance of some fishery products which are certain to attract significant market demand in India as well as in foreign countries. Some such products which are likely to exert an impact on foreign trade are Laminated Bombay duck, Bombay duck paste, smoked eel fillets and smoked and canned eel fillets.

674. GOVINDAN (T K)

Diversification: The only means of salvation for our seafood industry. *Seafood Export* J., 3(1), 1971 : 161 – 165.

In this article, the author deals with diversification in catches, processes and products. In India, curing method of preservation has to be given all possible encouragement, because fish preserved by the more sophisticated methods of freezing and cannig at present over -

shoots in cost the purchasing capacity of the common man, for whom at least for the time being, curing alone appears to be the most suitable method of preservation of this cheapest source of protein foods. The industry has to be entirely reorganised on modern lines with hygienic processing halls and plentiful supply of good potable water, the most esential prerequistes for any food processing factory. Diversification of markets is also a very important point to be taken care of in order to get maximum returns from our fishery products.

675. KURIYAN (G K)

Fishing in the deep. *Souvenir Fish Exporters Chamber*, Tuticorin, 1971.

Exploratory surveys have shown the existence of a fairly rich yearly potential of nearly 12 million tonnes of marine landings. Out of this, three quarters are landed on the west coast. The potential on the east coast still remains unexploited. The major factor responsible for this slow rate of increase is under-exploitation, especially of the deep seas owing to the non-availability of the larger vessels, the general paucity of many equipments and the meagre but essential infrastructural arrangements. The urgent need for the improvement of the above requirements is highlighted in this article by the author.

676. KURIYAN (G K)

Craft and gear. Seminar No. 141, Blue Revolution. 1971.

A brief resume of craft and gear used for the different types of fishing in India is outlined in this paper.

677. PILLAI (V K)

Processing of fishery products for export. *Foreign Trade of India* (Marine products), 1971 : 35.

The paper describes the methods of processing of various products like frozen and canned prawns, lobsters and frog legs etc. for export.

678. PILLAI (V K)

Fish processing. *Seminar* No. 141 (The Blue Revolution), 1971 : 18.

An account of different processing methods for preservation of fish is detailed inth is communication.

679. VENKATARAMAN (R)

Gujarat marches ahead. *Seefood Export* J., 3(1), 1971 ; 47-150.

The vast potentialities for developing prawn and lobster fisheries have been thoroughly investigated and the results passed on to the enterprising fishermen and merchants. Extensive work on trawling, standardisation of trawl gear for small powered boats, methods of handling, processing and preservation of the catch were worked out and passed on to the fishermen.

680. GOPALAKRISHNA IYER (T S) and KANDORAN (M K)

Proforma for assessment of the levels of sanitation in fish processing establishments. *Fish. Technol.*, 9 (2), 1972 : 109-114.

Sanitation score forms form part of the day to day long sheets in fish processing establishments in western countries. Based on the conditions available in India, a proforma for assessment of hygienic condition was prepared covering every aspect of sanitation which may directly or indirectly influence the quality of the end product. A few random surveys of some of the processing units located in this area have been carried out and the results compared well with the grading arrived at from separate bacteriological data collected from the same premises. Trial tests have given clear indication that a factory can easily score 65-70 marks when the minimum hygienic conditions are satisfied.

681. GOVINDAN (T K)

Cartilagenous fishes of India. *Seafood Export* J., 4(12), 1972:19-24.

The author discusses the use of this class of fish to humanity, eventhough they comprise some dangerous species which do not spare any opportunity of preying upon other fishes and animals, acquatic as well as terrestrial including human beings. Cartilagenous fishes belong to a class of acquatic life occupying a position intermediate between those of invertebrates and teleosts. The application of preservation techniques and extraction of oil from their livers are also dealt with this paper.

682. GOVINDAN (T K)

Mudbanks : A strange phenomenon of the Kerala coast. *Seafood Export* J., 4(5), 1972 : 15-17.

In the light of existing scientific knowledge on the subject, the author briefly discusses what a mudbank is and how it occurs in the Kerala coast.

Mud banks are a special and unique feature of the Kerala coast. Mud occurring in the mudbank area is dark green in colour and soft like butter and is entirely different from that in other areas. It has been shown to contain upto 0.004% of mineral oil, besides other mineral salts, organic matter and plankton, the chief good materials of fishes.

683. GOVINDAN (T K)

Harpodon Nehereus. *Seafood Export* J., 4 (6) 1972: 21-24.

The author deals with *Harpodon nehereus*, commonly called 'Bombay duck', an important fishery, especially along the Maharashtra and Sauashtra regions on the west coast of India.

Bombay duck is generally caught in staka nets of the same principle as the 'Oonnivala' of Kerala backwaters, but much larger in size. It is a carnivorus fish. Sophisticated methods of preservation, viz. freezing and canning have not yet been applied to this fish. The method of preservation applied to this fish is sun-drying to which 80% of the total landing is subjected, the remaining 20% being consumed in the fresh condition. A specially processed product out of this fish is called 'laminated Bombay duck' which has got some export market in UK and other European countries. Dried and irradiated Bombay duck keeps in fine condition for quite long periods provided subsequent contamination is prevented.

684. GOVINDAN (T K)

Highly relished food fish of India. *Seafood Export* J., 4 (11), 1972 : 27-32.

The Indian mackerel, (*Rastrelliger kanagurta*), occupies an important position in the Indian fishery as a delicious, nutritious and highly relished food fish. Some variations in moisture, fat contents and other chemical constituents of the mackerel muscle are liable to occur according to seasons. The important methods of preserving this fish are highlighted in the communication.

685. PILLAI (V K)

Technological research in India's fisheries development. *Indian Farming*. 1972.

One of the most important factors that has contributed towards increased production is undoubtedly mechanisation of the fishing operations through introduction of mechanised fishing vessels of new designs and adoption of new fishing gear and methods. Search for cheaper fishing boats is being continued by experimenting new materials like ferro-cement and marine quality aluminium for the hull and other structural parts, Technological research has also proved useful in the manufacture of marine engines for fishing boats. Efforts made towards increasingfish production from the inland resources cannot also be overlooked. The Institute's Processing Division, not only tried to keep ahead of the needs of the industry but also helped it from time to time to surmount technological problems that stood in the way of progress and development.

686. VELU (M)

Development of mechanised fishing in Tamil Nadu : Requirement of boats and machinery. *Proc. Seminar on Mariculture and Mechanised Fishing*. Madras, 1972: 199-203.

The present strength of mechanised fishing boats in operation in Tamil Nadu stands at around 750, consisting of vessels between 7.7 and 12.3 m. (25 feet to 40 feet) length overall, mainly engaged in fishing in the inshore waters below 50 m depth, the vast area beyond this limit remaining practically unexploited. The author has described 3 types of boats viz. small boats between 9-14m, medium boats between 15.5 m to 24.5 m and larger boats between 24.5 to 38.3 m for the requirement of Tamil Nadu coast. The capacities of engines and other accessories required for the different size groups of boats are also described.

687. GOVINDAN (T K)

Treasure from the sea bed. *Hindu weekly Magazine*, 6th May 1973.

There are about a hundred different species of prawns / shrimps, occurring in our waters. Bottom trawling is the most widely employed method of fishing and mechanisation of fishing crafts has paid dividents by increasing the prawn catches. Depending upon the method of preparation of the raw material, frozen prawns are classified into different catagories, viz. 'raw headless' or 'headless shell on' 'peeled and deveined' 'butterfly' or 'fan-tail' and 'cooked'. The ISI has formulated quality standards for frozen, canned and dried prawn products and compulsory preshipment inspection for them instituted by the Government of India from 1965. The economic utilisation of the head and shell of prawns will help to develop the industry further. Valuable pharmaceutical compounds like glucosamine hydrochloride and cholesterol can also be extracted from it. It also forms a source for a compound called 'chitosan'.

688. GOVINDAN (T K)

Marine Fisheries of Andhra Pradesh: An industry that yearns for expansion. *Seafood Expert J.*, 6(10), 1974 : 11-17.

The author describes the marine fishing industry of Andhra Pradesh and its immense potentialities for immediate development. There is ample scope for a 4 to 5 fold increase in the number of mechanised fishing boats in the state with simultaneous provision for landing and berthing facilities. The State also offers plenty of scope for artificial culturing of the foreign exchange earning prawns, besides several brackish water fishes like chanos, lates, mullets etc. for internal consumption in its extensive backwater and estuarine areas. Such developments will also provide employment to several thousands of people and thus boost up the overall economic conditions of the otherwise agriculture intensive State.

689. GOVINDAN (T K)

Oil sardine : A rich marine resource. *Economic Times*, 15th Dec., 1974:5.

Oil sardine (*Sardinella longiceps*) is an important marine resource of the country whose landings range from one to three lakh metric tonnes per annum. The method of preservation most commonly employed for other types of fish in our country viz. salting and drying, cannot be applied to this fish, as its high oil content gets easily rancid on drying, rendering it inedible in a fortnight's time. The fish is rich in body oil which has immense potentialities of industrial application. A modified method of extraction of oil from the sardines using aluminium vessels instead of iron for cooking the fish is a latest innovation. A method has already been reported for extraction of a fish protein concentrate in powder form fit for human consumption from the press cake left after extraction of the oil. The press cake termed 'guano' can also be used for manure and fish meal for poultry and cattle feed compounding. Recent researches have shown that the fish can be transported in frozen condition packed in thermocole-insulated plywood boxes over distances involving rail journeys of upto 3 days duration at ambient temperature.

690 GOVINDAN (T K)

Atom comes to farmer's aid. *Economic Times*, 26th Sept., 1974 : 5.

One aspect of the peaceful use of atomic energy on which a lot of research has been carried out both in India and abroad and which has vast potentialities of effecting considerable economy on our food front is its use in the preservation of food materials. Radioactive elements undergo a process of continuous disintegration emitting three types of particles viz. positively charged alpha particles, negatively charged beta particles and chargeless or neutral gamma particles. The process of partial or complete sterilisation of any material by this means is termed irradiation, radurisation or radio-pasteurisation. Highly perishable food articles, various food grains and all kinds of pulses whose main enemies are micro organisms are all amenable to preservation by this method. The degree of sterilisation attained by the food particle being treated is determined by the energy it absorbs in the process. A five-fold increase in the shelf life of meat at 40° F by irradiation with low doses of gamma rays has been recorded.

691. GOVINDAN (T K)

My legs earn foreign exchange for India, An autobiography of a frog. *Caravan*, 11, 1974: 52-53.

Until recently the only threats to frogs were from reptiles and to some extent students of Zoology who disect them to study their physiological constitution. But from 1959 on wards Indians have started to freeze frog legs to export them to USA, Belgium, France, W. Germany and Australia. In these countries the frog legs are considered a table delicacy. The ISI has laid down quality specifications for frozen froglegs. The Government of India has introduced in recent years compulsory preshipment inspection for the commodity.

692. GOVINDAN (T K)

Role of Sea-Wealth in Indian Economy. *Fisheries & Sea wealth*, 1(1), 1974 : 26.

The part played by marine products in the foreign exchange earning of India by way of its foreign trade has been high-lighted. The possibilities of better and more scientific utilization of the fishery resources of the country adopting the technological innovations evolved in recent years and consequent improvement in its overall economy have been pointed out.

693. KAIMAL (P N R)

Fish processing industry in India. Highlights of its future development. *Indian Seafood.*, 10 (2) 1974 : 7.

The crucial problems faced by the processing industry at present are shortage of raw material leading to underutilisation of the processing capacity, increasing cost of raw material and dwindling returns from the industry. It is evident that the present problems of the processing industry are essentially created by the industry's dependence on single raw material viz. prawns for its establishment and expansion. Effective solution to these problems lies in judicious utilisation of the other raw material resources available.

The technology involved for preservation, transport and marketing of fish either as fresh or frozen is now available. Efforts of CIFT, have resulted in evolving processes for a variety of products many of which hold out scope for export to any sophisticated market in the world.

694. KAIMAL (P N R)

India urged to vary seafood exports. *Fishing News International*, 13 (11), 1974: 51-52.

The continued expansion of the Indian seafoods export industry depends on reducing its heavy dependence on one commodity, shrimp and effectively and economically exploiting the fish component of the marine catch in overseas markets. Effective utilisation of the fish component of the marine catch lies in the establishment and development of markets for fish and processed fish products within the country and processing different types of fish products or fish based products exportable to sophisticated foreign markets.

695. MADHAVAN (P), UNNIKRISHNAN NAIR (T S) and BALACHANDRAN (K K)

Review on oil sardine : III-Oil

and meal industry. *Fish Technol.*, 11 (2), 1974 : 102-107.

C I F T has worked out and demonstrated successfully a method of extraction of oil of very good characteristcs giving an average yield of 12%. Application of modified sardine oil for the industrial purposes was achieved as a result of the investigations carried out at CIFT. The author has briefly accounted the salient features of fish meal, fish protein concentrate extracted out of oil sardine.

696. MATHAI (T Joseph).

Fisheries reconnoissance and extension service. *Seaf. Exp.* J. 6 (10), 1974: 33-36.

Recently a lot of developments have been brought to bear on fish detection and location. These can broadly be classified into oceanographic and hydroacoustic devices. The former gives basic information regarding the favourable environs where fish are likely to be detected. The latter helps in pin-pointing the presence of fish, identifying the species and assessing the quantitative and qualitative nature of the school. Some suggestions have been incorporated to help increase the efficiency of the fishing fleet and effectively curtail the time and expenditure incurred on scouting for fish shoals.

697. GOVINDAN (T K)

Fish processing industry in India: A retrospective, present status and future prospects. *Seafood Export J.*, 7(1), 1975 : 143-147.

The fishing and fish processing industries in India have made rapid strides in the last two decades, boosting up the rank and prestige of the country among the maritime nations of the world. Though this is a commendable achievement over the primitive and outmoded conditions of the industry prevailing prior to this period of renaissance, it leaves no room for complacency as much more remains to be achieved in this field More than 90% of our export earnings from marine products are derived from a single variety viz. prawn which contributes only 10-12% of our total marine fish landings and consequently all important activities are centred round this commodity. An all round deverification in harvesting, processing and marketing, side by side with modernisation of our traditional fish curing industry and proper and economic utilisation of the by-products of the industry alone can effect any substantial improvement in the future performance of the industry.

698. KAIMAL (P N R)

Fish protein to fight malnutrition. *Indian Farming*, July 1975.

Fish is one cheap source of high quality protein, which contains all the amino acids essential for human nutrition and 70% of it is digested. 100g. of fish protein provides about 100 to 110 calories. In contrast to cereal proteins it contains two essential amino-acids, lysine and methionine, which are essential for nutrition. Excellent products can be processed out of trash or cheap varieties of fishes. One such product is fish protein concentrate (FPC) which is a colourless, odourless and tasteless form of pure protein. Its digestability is 85%. Fish protein can be hydrolysed to proteoses,peptones,peptides and amino acids employing hydrolytic enzymes or acids. The hydrolysates containing peptones and amino acids are excellent products with high nutritive value and they can be used for preparation of protein-rich, ready-to-use energy foods. Fish soup powder is yet another product to fight protein malnutrition.

699. KURIYAN (G K)

Fish preservation. *Symposium Fish Proc. Ind in India*, Mysore, 1975: 19-22.

The main objective of technological research in the field of fish preservation and processing is to work out methods and methodology to maintain the freshness of fish during handling and storage for extended periods. During storage, crushing and handling, ice may get contaminated with bacteria which in turn contaminate the fish and hasten bacterial spoilage. In the efforts to improve the keeping quality of fish in ice, a number of preservative or bacterioides have been in corporated with ice. It has now been established that chlorotetracycline would enhance the shelf life of fish for extended periods in ice. Freezing is no doubt the most important method of preservation in that it retains the fresh fish quality for longer periods. Canning consists essentially in packing fish, fish fillets or prepared fish products in hermetically sealed containers in suitable medium like brine, oil, sauce etc. and thermal processing in order to ensure almost complete sterility of the product.

700. KURIYAN (G K)

Technological research in Indian fisheries. *Seafood Export* J., 7(1), 1975 : 37-40.

Mechanisation of fishing crafts, introduction of mechanised boats of new designs, use of improved gear materials and gear designs, adoption of modern fishing technique, fish preservation and processing methods all contributed towards development of the industry on scientific lines Results of technological investigations have their remarkable influence on these striking developments that took place in the fishing industry.

701. MATHEN (Cyriac), THOMAS (Francis), MATHEW (Annamma) and JOSEPH (A C)

Survey on the quality of Indian fish meal of commerce. *Fish. Technol.*, 12(1), 1975 : 16-20.

Data on proximate composition, total volatile bases, total non-protein nitrogen and bacterial quality of commercial samples of Indian fish meal are presented. The samples vary very much in quality depending on the type of raw material used and method of processing followed. The data are discussed in relation to the Indian Standards Specifications for fish meal as livestock feed.

702. MHALATHKAR (H N), RAMARAO (S V S) and MATHAI (P George)

New one boat mid-water trawl for Indian waters. *Fish. Technol.*, 12(1), 1975 : 37-44.

The paper describes a new design of 10.5 m four-equal panel mid-water trawl, its rigging and operation from a medium size vessel comprehensive comparative efficiency studies of this gear with a 10.5 m unequal panel mid-water trawl established the superiority of the new gear. The gear evolved and rigging can be nitroduced for commercial fishing from medium vesels.

703. BALACHANDRAN (K K)

On the carotenoid pigments in Indian shrimp. *Fish. Technol.* 13(2), 1976 : 121-125,

Deterioration occuring in carotenoid pigment of prawns during different types of processing and storage has been a matter calling for a scientific solution

for which a knowledge of their fundamental nature is essential. A detailed account of the methods employed in isolating the individual pigments and the results achieved in their identification are presented in this paper.

704. BALACHANDRAN (K K) and NAIR (M R)

Prospects for canning fish and shell fish in India *Proc. Handling, Processing and Marketing of Tropical fish, TPI London*, 1976 : 303-306.

The export-orientated seafood canning industry of India is based exclusively on prawns. Prawns canning suffered a serious slow-down in racent years due partly to the decline in world demand for canned prawns and partly to the abnormal increase in the costs of raw prawns and cans in the country. This resulted in much of the plant capacity remaining idle. The probable solution for revival of the canning industry appears to be diversification of its pro duce by including commodities other than prawns, for which there are existing international markets. Possible commodities are sardine, mackerel, clams mussels, oysters etc. which are available in plenty in the country. The technology for canning most of these commodities has already been develcped.

705. KANDORAN (M. K)

Fish in nutrition and economy. *Seafood Export J.*, 8 (4), 1976: 23-27

The nutritive value of fish depends on the amino acid make-up of the protein present in the fish. Out of the 19 amino acids commonly occurring in food proteins, ten are supposed to be essential amino acids that can not be synthesised in the body. The high degree of digestibility is a special advantage of fish. The fish is a potential agent for combating malnutrition. Production and marketing of conventional and diversified products from various species of fish and shell fish are essential for the healthy growth of the fishing industry in our country.

706. KURIYAN (G K)

Fish product development in India. Symposium on Handling, Processing and Marketing of Tropical Fish, TPI, London, 1976.

The collapse of the Indian trade in traditional dry/cured fishery products with the neighbouring countries at the end of the world war II, was followed by its regeneration on modern lines catering to the sophisticated markets in the West. There is now a greater awareness of fhe diversification of fishery products and markets. Research work has been initiated in different laboratories in the country to devise ways and means to turn out new products which can have potential markets within the country and abroad. The results have been ecouraging and many new products frozen, canned and speciality products involving minced fish meat and hydrolysed meat, new cured products of extended shelf life and by-products have been developed.

707. KURIYAN (G K)

Towards a better export performance. *Indian Seafood* 11 (1-4), 1976: 72-73.

Marine products exports from India reached the all-time high in 1975 even, possibly beyond normal expectations. With the technology for processing diff-

erent products indigenously available the right type of machinery has been emphasised as one of the most important requirements of the industry to venture on any product. The technology developed indigenously in this respect is transferred to the industry through demonstrations, training of personnel and by other means. Trade fairs organised by the MPEDA have helped in increasing our exports of processed fish products.

708. VENKATARAMAN (R) and DEVADASAN (K).

Some suggestions for the better utilization of the fishery resources of Gujarat. *Seafood Export J.*, 8 (1), 1976 : 87-90.

Investigations conducted on the methods for proper utilization of the major fisheries of Gujarat are incorporated. Suggestions for better utilisation of fishes like elasmobranchs. eels, pomfrets, hilsa, dhoma, prawn, lobsters and Bombay duck are discussed in this paper.

709. GOVINDAN (T K)

India's seafood exports : A critical review *Seafood Export J.*, 10(1), 1978 : 73-76.

The export of marine products from India during 1976 reached an all-time high, registering a growth of 16% in terms of quantity and over 71% in terms of value over those of 1975. A closer look reveals that shrimp frozen, canned and dried, constituted 89.56% and frozen products accounted for 97.07% of the export. This particular point deserves special attention because of the overdependance on one particular commodity and one particular processing method. The greater demand for frozen shrimp, with the consequent increase in purchase price of the raw material as well as the high cost of the tin container in our country have mainly contributed the decline of canned shrimp. Dried fish is another of our traditional export commodities which had a flourishing market in our neighbouring countries during the pre-independence period. There are methods, available for the application of chemical preservative treatments to the product for imparting fairly long shelf life, enabling its wider distribution over longer periods. There is scope for further improvement of exports of shark fins and fish maws by adopting the technology recently developed for separating the fin rays from fins resulting in higher returns.

710 KURIYAN (G K)

Some aspects on fish handling and preservation. *Souv. Industrial Fisheries Ass., University of Cochin*, Cochin. 1978: 5-6.

The primary objective of technological research in fish handling and preservation is to study methods to maintain freshness of fish both while handling and storage. The loss in quality of fish can be attributed to three main factors, viz autolytic action, bacterial contamination and oxidation. During storage, crushing and handling ice can get conaminated which in turn contaminate the fish and hasten bacterial spoilage. In frozen fish, during storage, certain undesirable changes do take place like denaturation of protein, dessication, oxidative rancidity and loss of flavour. Various protective coverings or glazes have been developed, of which the simple ice glaze is what is extensively practised by commercial freezers. Canning is yet another method for preservation of fish. Great progress has been achieved in the field of canning.

711. KURIYAN (G K)

Some aspects about Fisheries Development in tropical countries with particular reference to processing and marketing. *Seafood Export J.*, 10 (1), 1978 : 1-3.

Development of fis1eries in the tropical countries is faced with many complex problems, particularly in the fields of processing and marketing. According to a sruvey conducted by FAO, fish production in tropical waters has increased in recent years. The production comprises of 80% marine fish and 20% inland fish. In the majority of cases, the fishery resources currently exploited in the tropics can be considered to be 'on-shore' and 'near-shore stocks. Due to the possible interaction of time and temperature and the inadequancy of the fishing technique, the tropical coastal fishermen are not able to fish 'off-shore, which might eventually prove more beneficial. If the fish landings are made in orclose to urban centes, the problems of distribution and marketing are substantially reduced. Some of the action strateg ies for tropical countries are incorporated in this article.

712. GOVINDAN (T K)

Indian Fish Processing Industry: Performance and perspectives. *Industrial Fisheries Ass., University of Cochin*, Cochin, 1979: 1-5.

The overall performance of the fishing and fish processing industries of independent India has been comparable to that of any developed country of the world. The seeds of modernisation of the industry were sown with the establishment of the Exploratory Fishery Project of the Government of India, the Indo-Norwegian Project at Quilon and the concerted efforts made towards mechanisation of fishing crafts by the maritime Stats Governments of the country. A full fledged All-India fish processing technological research laboratory established in Cochin in the year 1958 worked out the much needed methodologies of hygienic processing and solved the existing problems threatening the industry.

713. GOVINDAN (T K)

Rigor mortis in fish: The phenomenon and its significance: *Seafood Export J.*, 11 (1), 1979: 37-40.

Rigor mortis is a phenomenon which occurs in the bodies of all animals, closely following their death. The course of rigor mortis in fishes depends upon several factors such as the species and size, type of death, temperature at which held etc. A survey of existing literature on the subject shows widely varying and rather confusing cosflicting data on these aspects. However, some broad generalisations can be made. If the fish is filleted before the on-set of rigor, the fillets sometimes pass into rigor, before reaching chilled or frozen temperature, resulting in severe contractions accompanied by fair loss in weight. Information on the details of time taken for on-set of rigor mortis, attaining its peak, duration and resolution are also important on factory ships where the harvested fish has to be processed under optimum conditions. It has been observed that prawns canned immediately after catch (pre-rigor) were inferior on overall quality to those canned after a certain interval, after catch, indicating the obvious influence of the phenomenon of rigor mortis on the quality of the processed product and hence the need for a certain period of maturing for development of the required desirable characteristic flavour and texture.

714. MUKUNDAN (M K) and NAIR (M R)

Rigor moitis : A nature's gift to be taken advantage. *Seafood Export J.* 12(1), 1980 : 21–23.

Normally the body of any organism after death becomes stiff or rigid This death stiffening is called 'rigor motis'. The times of onset and duration of rigor are governed by a number of physiological and environmental factors. In fish usually the rigor sets in one to seven hours after death. The duration of rigor varies from 20 to 70 hours which largely depends on the premortum muscular activity and temperature. The causes of rigor viz. tha chemical, physical or environmental factors are enumerated in this paper by the authors.

715. SUBRAMANIA PILLAI (N)

Diversification of fishing methods: Some aspects. *Fisherman*, 1(2), 1980 : 30-32.

Diversification of fishing methods definitely helps in increasing fish production. Gill netting for seer, purse seining and mid-water trawling have been already standardised by CIFT and have been popularised. There are also other types of fishing methods introduced by CIFT such as troll line fishing, long-line, hand lining etc. which can also be taken up from mechanised vessels for catching some of the very good quality fishes such es seer, barracuda, tunnies, sharks, cat fishes, kalava etc The author has outlined the above new fishing methods for exploiting the resources.

ABBREVIATIONS

ADI	–	Acceptable daily intake
AF	–	Anti fouling
AFD	–	Accelerated freeze drying
AOAC	–	Association of official analytical chemists
ATP	–	Adenosine triphosphate
Ag/AgCl	–	Silver/Silver chloride
Al–Mg	–	Aluminium – magnesium
As_2O_6	–	Arsenic oxide
BARC	–	Bhaba Atomic Research Centre
BF	–	Block frozen
BG	–	Brilliant green
BGS	–	Brilliant green sulphadiazine
BHA	–	Butylated hydroxy anisole
BHP	–	Brake horse power
BHT	–	Butylated hydroxy toluene
BIS	–	Bismuth sulphite
BP	–	Boiling point
CaO	–	Calcium oxide
CFTRI	–	Central Food Technological Research Institute
CIFE	–	Central Institute of Fisheries Education
CIFRI	–	Central Inland Fisheries Research Institute
CIFT	–	Central Institute of Fisheries Technology
CMFRI	–	Central Marine Fisheries Research Institute
CNSL	–	Cashewnut shell liquid
CP	–	Cooked and peeled
CRT	–	Cathode ray tube
CTC	–	Chloro tetracycline
DSB	–	Double side band
DSe	–	Dulcitol Selinite
DWB	–	Dry weight basis
EDTA	–	Ethylene diamine tetra acetic acid
EHP	–	Engine horse power
FAO	–	Food and Agriculture Organisation
FFA	–	Free fatty acid
FPC	–	Fish protein concentrate
FRP	–	Fibreglass reinforced plastics
HDPE	–	High density polyethylene
HL	–	Headless
HP	–	Horse power
Hz	–	Hertz
IQF	–	Individual by quick frozen
IS	–	Indian Standards
ISI	–	Indian Standards Institution

K_2HPO_4	–	Dipotassium hydrogen phosphate
KHz	–	Kilo Hertz
Mg	–	Magnesium
Mol. wt.	–	Molecular weight
NaCl	–	Sodium chloride
NaH_2PO_4	–	Sodium dihydrogen phosphate
NDGA	–	Nor-dihydro Guaretic acid
$-NH_2-N$	–	Amino - nitrogen
NPK	–	Nitrogen phosphorus potassium
NPN	–	Non-protein nitrogen
NPR	–	Net protein retention
$Pb/Pb\ So_4/PbO_2$	–	Lead / Lead sulphate / Lead oxide
PBG	–	Peptone beef extract glucose
PBGA	–	Peptone beef extract glucose agar
P & D	–	Peeled and deveined
PDP	–	Potassium dihydrogen phosphate
PER	–	Protein efficiency ratio
PPI	–	Plan position indication
PV	–	Peroxide value
PVC	–	Poly vinyl chloride
P_2O_5	–	Phosphorus pentoxide
pH	–	Hydrogen ion concentration
ppm	–	Parts per million
R & D	–	Research and development
RH	–	Relative humidity
r. p. m.	–	Revolutions per minute
RSW	–	Refrigerated sea water
SC	–	Selinite cystine
SEN	–	Salt extractable nitrogen
SPC	–	Standard plate count
SSB	–	Single side band
STPP	–	Sodium tripolyphosphate
SWA	–	Sea water agar
SWG	–	Standard wire gauge
TBA	–	Thiobarbituric acid
TBTO	–	Tributyl tin oxide
TMA	–	Trimethyl amine
TMAN	–	Trimethyl amine nitrogen
TMAO	–	Trimethyl amine oxide
TN	–	Total nitrogen
TNAU	–	Tamil Nadu Agricultural University
TPC	–	Total plate count
TVB	–	Total volatile base
TVF	–	Total volatile fluids
TVG	–	Time varied gain
TVN	–	Total volatile nitrogen
UK	–	United Kingdom
UN	–	United Nations
USA	–	United States of America
VAN	–	Volatile acid number
WEN	–	Water extractable nitrogen
WHO	–	World Health Organisation
WSN	–	Water soluble nitrogen
w/w	–	Weight by weight
XLD	–	Xylose lysine desoxycholate

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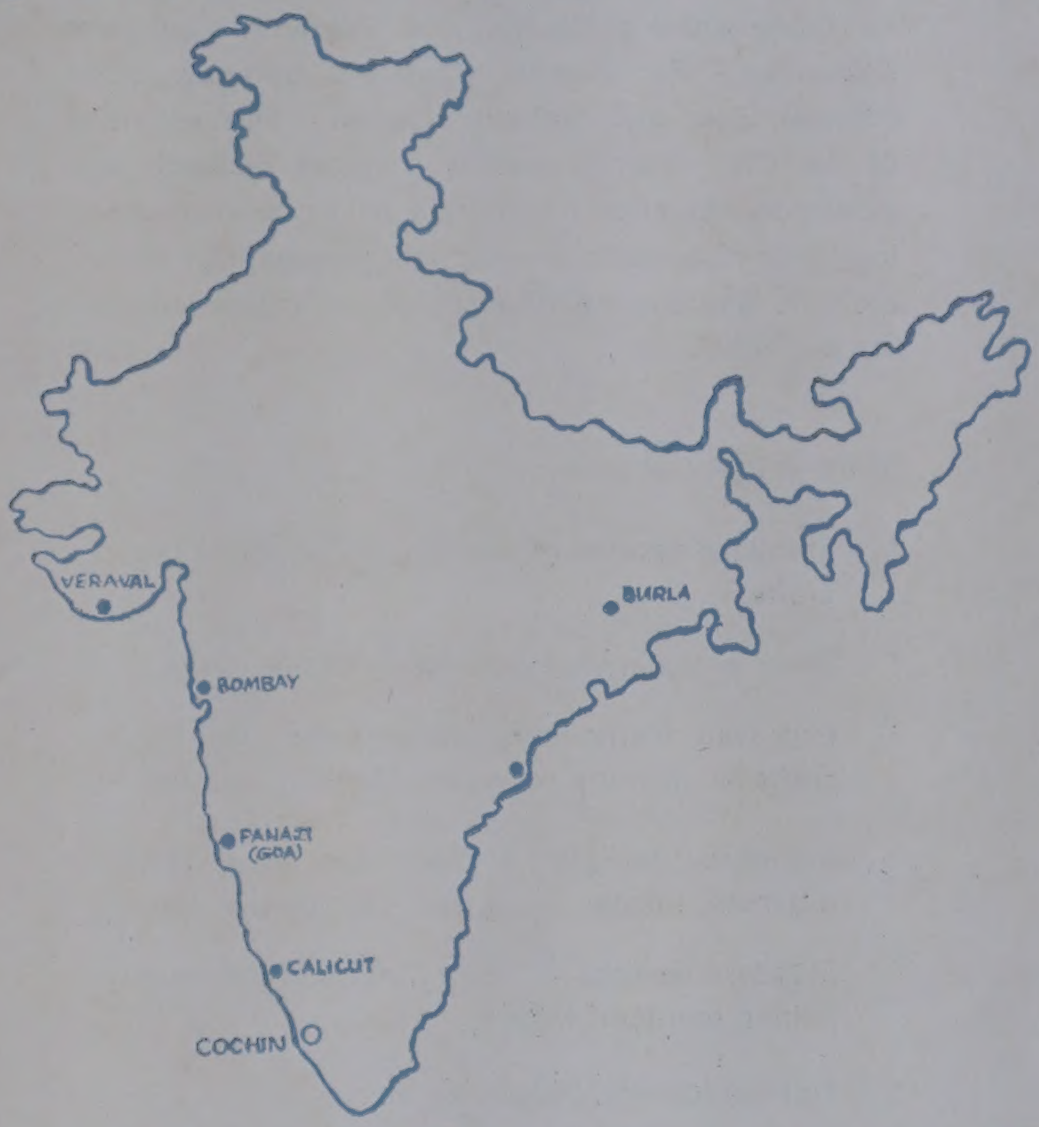

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